

Basic Instinct: Magnesia Supply to the Refractories Industry

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If ever there was a time to acknowledge and try to understand the significant influence of Chinese policies on refractory mineral supply to western markets that time is now. The upshot is that 2017 will be remembered as the "Year of the Perfect", or, perhaps, ... "Imperfect Storm" – depending on whether one is a Western refractory mineral producer/developer or a Western consumer of Chinese refractory minerals, respectively.

1 Introduction

The leading steel refractory producers – such as RHI Magnesita, Vesuvius, Minteq, HarbisonWalker – are suffering at the time of writing (early December 2017), in that it has been very difficult to secure refractory mineral supply and prices for H1 2018, let alone rest of 2018 and 2019.

The cumulative effects of swift and robust central government policies in cracking down on pollution (leading to plant closures), explosives provision (limited or no mine blasting), and unlicensed businesses (companies closing), not to mention domestic market demand factors, have combined to create a storm of severe shortages and soaring prices for key refractory minerals exported from China.

The impact has been keenly felt by consumers of dead burned and fused magnesia, plus other refractory raw materials such as calcined bauxite, brown fused alumina, silicon carbide and graphite.

This is not a cyclical phase; the fall-out is unlikely to be temporary for many operations; this time it's serious.

By the time this article is published, perhaps the outlook will be slightly clearer, but

Scale of magnesia grade processing		Increasing price USD/tonne		
		Avg. China 2016 export	2017 China FOB pricing	
Increasing temp. °C heat treatment Decreasing reactivity Increasing refractoriness Increasing energy cost	2 800-3 000°C	electrofused magnesia 96-98% MgO	USD 500	USD 400-1200
	1 500-2 300°C	dead burned magnesia 90-97.5% MgO	USD 240	USD 250-1000
	1 000-1 500°C	hard burned caustic calcined magnesia	USD 200	USD 200-500
	700-1 050°C	light burned caustic calcined magnesia		

Fig. 1 Grade diversity of magnesia raw materials

frankly, 2018 is expected to remain a tough time for consumers of refractory minerals. This article focuses on supply of refractory grade magnesia.

2 Magnesia basics

Without refractories, there would be no steel, non-ferrous metals, glass, and cement production, just to name a few dependent market sectors. But without industrial minerals, there would be no refractories – refractory minerals are the "DNA" of refractories.

Dead burned magnesia (DBM; 85–99,8 % MgO) and fused magnesia (FM; 97–99,8 % MgO) are two of the primary workhorse mineral derivatives used in many refractory formulations. After refractory clays, magnesia is the second most consumed refractory mineral by volume.

Magnesium oxide, or magnesia (MgO), is derived from two main sources: from naturally occurring minerals, mostly magnesite (but also from other mineral such as serpentine, dolomite, huntite, bischofite) known as "natural magnesia", and from sea water and magnesium-rich brines known as "synthetic" magnesia.

2.1 Resources and production

According to data from the US Geological Survey, almost 12 Mt of MgO equivalent is produced worldwide of which 89 % is derived from natural sources and 11 % from synthetic sources.

Of the world's magnesite resources, about 90 % is of the sparry, macrocrystalline, coarse-grained type hosted by carbonate rocks, and 10 % of the cryptocrystalline, fine grained type hosted by ultramafic or fresh sedimentary rocks.

Increasing heat treatment (calcination, sintering, electrofusion) produces a range of magnesia grades (with corresponding price increments), of which dead burned (1500–2300 °C) and fused magnesias (2800–3000 °C) are suitable for refractory use. Fused magnesia maybe produced direct from magnesite or from caustic calcined magnesia.

World production of natural DBM is estimated at 7,7 Mt and synthetic DBM at 0,8 Mt.

The majority of the 8500 Mt of world reserves of magnesite are hosted by Russia (27 %), China (20 %), North Korea (18 %), followed by Turkey, Australia, Brazil, Greece, Slovakia, India, and Austria, at 5 % or less. Magnesia production is dominated by China (69 %), followed by Turkey (10 %) and Russia (5 %), and others at 3 % or less.

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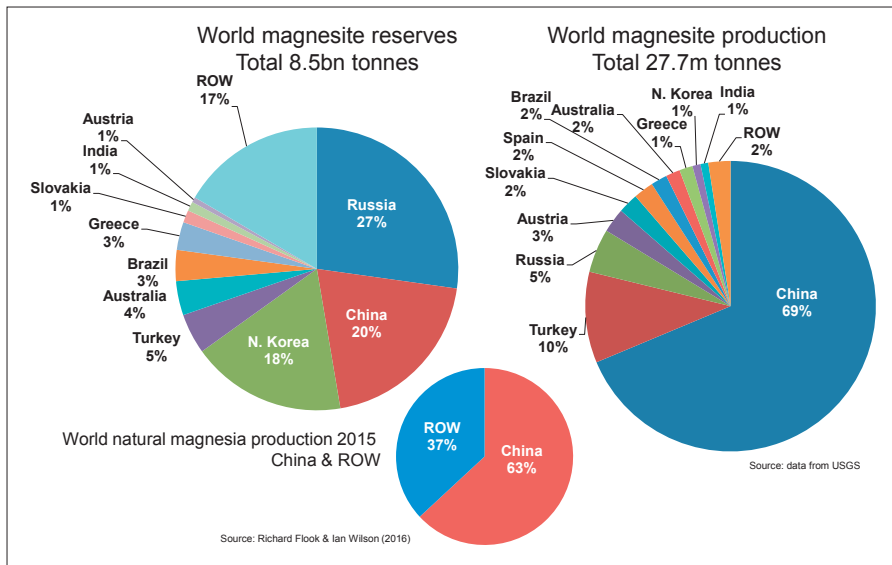


Fig. 2 Natural magnesia resources

While magnesia sources may occur in many countries, there are actually only limited commercially developed sources of refractory grade magnesia which maybe termed primary sources: Australia, Brazil, China, Greece, Ireland, Mexico, Netherlands, Slovakia, Spain, Russia, Turkey.

In 2016, China produced 3,4 Mt of DBM and 1,38 Mt of FM. Not surprisingly, China still dominates exports at 42 % (1,8 Mt) in 2016.

There are other, “secondary” sources of refractory magnesia, but these are mainly either captive producers or supply only local markets, or have small scale production. When reviewing the key importing countries of magnesia, it is instructive to note that the top eight importing countries are also host to the world’s no.1, 2, 4, 6 and 7 ranked

largest steel producing countries – reflecting the steel industry as the primary driver for refractory demand. The top 11 magnesia importing countries accounted for 74 % of crude steel output in 2016.

In general, refractory magnesia production can be summarised by the following characteristics: as having mostly natural, few synthetic producers; with mostly 1–2 producers per country (except China and Turkey); many are part of large, integrated groups; some of these are captive producers; some serve mostly local/regional markets; outside China there are very few FM and high purity DBM producers; some have diversified away from refractories into industrials/specialities; world supply is dominated by China; and refractory magnesia demand is driven by steel markets.

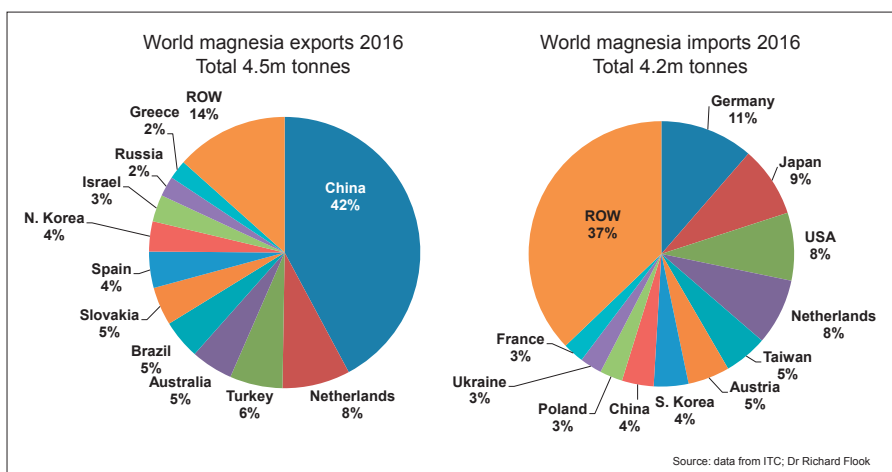


Fig. 3 Primary trade (exports/imports)

2.2 Trends and developments

The three main areas of trends and developments, which are affecting the refractory magnesia industry are corporate ownership, capacity changes, and China.

The last 30 years have seen a gradual shrinking of the refractory magnesia supply sector outside China and with it consolidation of ownership of the world’s main magnesia sources, perhaps peaking in 2017 with the “magnesia mega-merger” of RHI and Magnesita, which concluded on 26 October 2017.

Parallel to consolidated corporate ownership has also been an increase in vertical integration, mainly pursued by RHI, Magnesita, and Magnezit, each striving to attain at least 80+% raw material supply security. Refractory producers Minteq and Refratechnik also have captive magnesia sources.

In response to market demand, and the evolving situation in China, there are a number of interesting developments with regard to existing refractory magnesia production facilities and projects:

2.2.1 Existing producers:

IBAR/BR

- recent expansion; from 2016 40 ktpa DBM for export with Cofermin Magnesium do Brasil/BR
- expansion 2015/16; by 2020 150 ktpa incl. 40 ktpa DBM Magnesitas Navarras/ES
- 2017: Upgrading kiln no. 2 Zubiri to increase DBM cap. to 200 ktpa
- Borobia mine (Magnesitas Sorianos 250 ktpa crude ore); permit delays since 2011; initial ore extraction 2015; on stream July 2017

Nedmag/NL

- Feb. 2016 EUR 122 million investment for new salt extraction site; permitting 2018, development wells by 2022

RHI/NO

- 2012: 85 ktpa FM plant
- 2014: technical issues, reduced utilisation
- Dec. 2017: restart with “increased output”

Magnezit/RU

- 2017 Satka: started new 100 ktpa MHF
- + 130 ktpa DBM (2 x new shaft kilns 80 ktpa + 50 ktpa)
- Autumn 2017 construction of new 50 ktpa FM on stream 2019–20

- 2020 Krasnoyarsk: new 50 ktpa FM followed by Phase 2 50 ktpa FM
- 2020 cap.: 630 ktpa DBM (12 x SK 500 ktpa + new 2 x SK 130 ktpa); 170 ktpa FM (70 ktpa + new 100 ktpa)

IRRPCO/IR

- 2015: 9 ktpa FM plant started; 52 ktpa DBM;
- 2017: new monolithics plant

Kumas/TR

- 2015: 4 x EAF 40 ktpa FM capacity
- 260 k DBM-CCM-DBD capacity

Turkmag/TR (Cihan Group)

- 100 ktpa 86 % + 94 % MgO DBM Askale, eastern Anatolia
- 2011: start-up then mothballed
- 2014: RHI abandoned acquisition
- 2016: restarted in July
- 2017-18: planning 2nd rotary kiln to expand cap.

Sibelco/AU

- 2015-17 cutbacks in output and staff (30 %)
- Reduced MHF utilisation; no DBM (110 k cap.)
- focus on FM (30 ktpa cap.)
- Gas price rise: 2012-18 A\$4.25/GJ to A\$12-15/GJ

2.2.2 Brownfield Projects

IMC (Ma'aden), Saudi Arabia

- Ganmag Magnesite Solutions (N. Gangu-tia)
- July 2017: start-up of vertical shaft kiln, direct sintering, 33 ktpa low SiO₂, 92 % + 95 % MgO DBM; reporting much interest from market
- Sept. 2017: 36 ktpa mixing plant for monolithics; GCC steel market >100 ktpa

Ternamag/GR

- 2012: started mining at Gerorema on Euboea Is.
- 2014: 1st shipment raw magnesite, then MHF CCM (60 ktpa cap.)
- 2017: commencing Phase 2 construction of 60 ktpa rotary kiln for DBM+CCM

• April 2018: start-up

JORMAG, Jordan

- 2005: Al-Safi plant MHF + HT VSK on-stream 50 ktpa syn. 98 % DBM, 10 ktpa CCM; APC halted operations
- Feb 2017: sold to Manaseer Group for USD 12,5 million
- Q3 2018: plan to bring on stream, CCM first, DBM decide later.

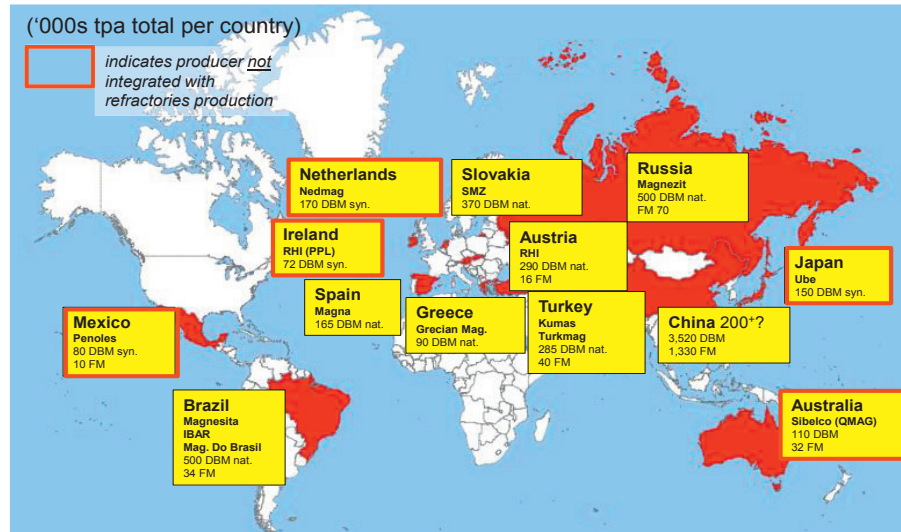


Fig. 4 Primary refractory magnesite sources and capacities

2.2.3 Greenfield projects

AusMag (Korab Resources)/AU

- Winchester magnesite deposit, NT; 16,6 Mt @ 43,2 % MgO; 1,5 Mt raw magnesite offtake agreement

Thessaly Resources/AU

- Huandot, NT deposit, 9 Mt @ 44,3 % MgO for CCM 95 %, 90 % and 85 % MgO

Leigh Creek Magnesite Pty Ltd/AU

- 453 Mt @ 41,4 % MgO; CCM, DBM

EcoMag Australia, South America

- PFS; 2017–2021 to produce >99,5 % MgO pure hydrated magnesium carbon-

ate (HMC), hard burned magnesite (HBM) and magnesium hydroxide (MDH) recovered from waste bitters discharged from salt works and potash mining in WA and Li-Mg salar brines in South America.

- 500 ML/year bitters (4 % Mg) = 78 ktpa HMC

MGX Minerals Inc./CA

- Driftwood Creek Magnesium Project, Brisco, BC: M+I 8 Mt @ 43,31 % MgO; pilot plant; PEA underway, CCM, DBM.

Karnalyte Resources/CA

- Wynyard Potash Project, SK; 7,9 Mt MgCl₂ probable reserves

Tab. 1 Corporate landscape

Company	Ownership	Integrated Semi-captive
IBAR Nordeste	IBAR - Brazilian Industries Articles Refratários	Y
Grecian Magnesite	Private (Portolos Family)	Y
Kumas	Kobin Madencilik İnşaat ve Ticaret A.Ş. (2012; namechange to Kumas Manyezit Sanayi A.S)	Y
Magnesita	GP Investiments (35,29 %); Rhône (8,26 %); Free Float (54,78 %); Treasury (1,68 %) Merger with RHI concluded end-Oct 2017	Y
Magnesitas Navarras	Groupe Roullier (60 %); Grecian Magnesite (40 %; in 2000)	Y
Magnesium do Brasil	Hermano Franck (50 %); Groupe Roullier (50 %; in 2013)	Y
Magnezit	Magnezit Group JSC	Y
Nedmag	Lhoist Group (50 %); NOM (50 %)	N
Penoles (Magnelec - Química del Rey)	Industrias Peñoles SAB de CV (Grupo BAL)	N
RHI	RHI (61 %); MSP (28,5 %); Chestnut (5,2 %); Silver (5,2 %) Merger with RHI concluded end-Oct 2017	Y
SMZ	SMZ a.s. Jelšava	Y
Sibelco Australia	SCR-Sibelco NV (acquired QMAG 2012)	N
Ube Material Industries	Ube Industries Group	Y

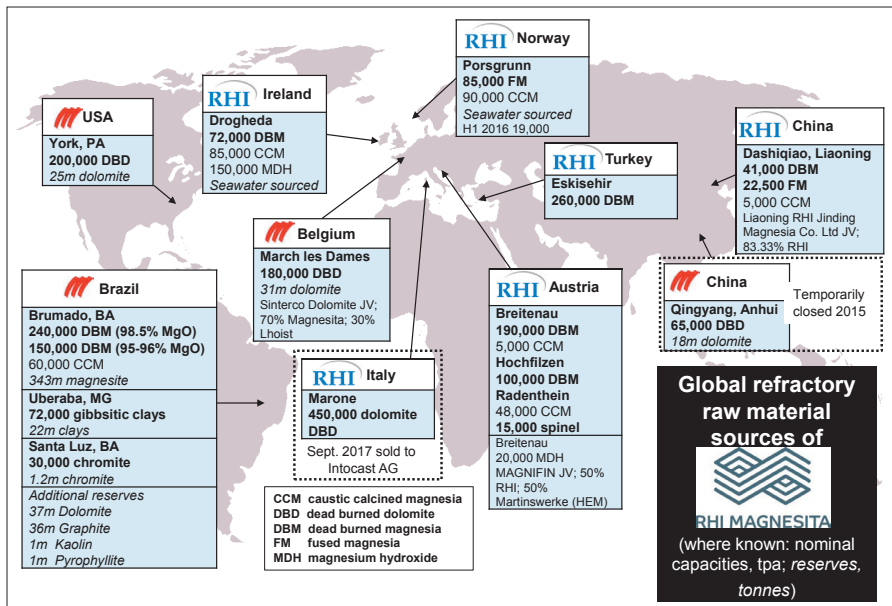


Fig. 5 Global refractory raw material sources of RHI MAGNESITA

- PFS for 100 ktpa $MgCl_2$ brine and 104 ktpa basic magnesium carbonate
- Gujarat State Fertilizers & Chemicals (21,5 %) 20 year potash offtake agreement
- "construction ready", chasing financing

3 China

The year 2017 will certainly live long in the memory of any trader or consumer of Chinese refractory minerals, and refractory magnesita was no exception.

The year started with the abolition of the much maligned export quota system, initiated in 1994, evolving and frustrating the global market annually to 2016's export volume quota of 1,7 m tonnes magnesita, with export licences quoted at RMB140–330 (USD 20–48)/tonne; export tax 5 % CCM, 10 % for DBM and FM.

A combination of pressure from the USA, the EU and the WTO, and the Chinese wishing to establish a new Foreign Trade Zone in Liaoning resulted in the export quota system being discarded from 1 January 2017. This almost immediately resulted in an increase in magnesita export volumes and a lowering of prices at the start of 2017.

However, this was short-lived as a triumvirate of central government decreed and implemented measures were brought to bear from February to the end of the year with clinical and unflinching force: environmental inspections of mines and plants; control

of explosives provision; and a crackdown on illegally operating companies.

In summary, this brought about an almost instantaneous closure of 80–90 % of magnesita production capacity in Liaoning as plants were closed for inspection. Some operations were able to restart later in the year, although many others need to invest in and install suitable antipollution equipment in order to restart, if at all.

The enforced ban on dynamite provision naturally curtailed any mine blasting activities and thus availability of primary raw material has been severely restricted, thus impacting feedstock for calcination plants. Like other minerals in China, much of the industry capacity is made up of small and medium sized companies, many of which have sailed close to the wind regarding their book keeping and business practices. Many such companies may now fall foul of State Council Order 684 against "undocumented and unlicensed operating procedures" effective 1 October 2017.

The upshot has been a sudden and severe shortage in refractory magnesita from China accompanied by an unprecedented increase in export prices: DBM 95–96 % MgO FOB China up from USD 300–400/t in January 2017 to USD 900–1200/t in November 2017; FM USD 400–600/t to USD 100–1200/t, according to Refractory Window.

4 Outlook

In a nutshell, regarding China and the impact on mineral supply: this time it's serious.

Xi Jinping consolidated his position as China's premier for a second term at the 19th National Congress of the Communist Party of China (NCCPC) in October 2017 and his party will continue to drive home its reforms, including its robust clean-up of the environment and business practices (a potential Environmental Tax has been mooted for 2018).

Continued tight supply and high prices for refractory minerals (especially fused minerals with power rationing and shutdowns enforced over winter) are expected into Q2 2018, and likely H2 2018.

Although prices may peak soon, physical availability is the key issue. With some operations remaining closed and others having difficulty in securing environmental (and business) permits, we should expect to lose some Chinese refractory magnesita production capacity in 2018/19.

There is also a move to reform the magnesite industry in China to a single, part state-owned entity, China Magnesite Mining Co. Ltd, responsible for the majority of magnesite supply. Should this come to fruition, then it is yet another transformation the market will need to adapt to.

A wider issue is the potential game changer of refractory producers considering and evaluating the potential for adopting alternative refractory formulations to ease reliability on the magnesita input – perhaps using more refractory dolomite, alumina-based alternatives, and increased refractory recycling.

The flip side of course is that it has given a new lease of life for the existing, emerging, and potential new sources of refractory magnesita outside China. These will aim to reassure consumers of future consistent supply and quality and pick up the shortfall in supply from China.

However, any investment/start-up needs to be now and there needs to be increased alliances with the refractory manufacturers. 2018 is already looking to be as exciting a year as 2017 for refractory magnesita.