

Magnesia markets — refractory contraction and caustic stagnation

by Brian M. Coope*

The recent history of the world's magnesite and magnesia industry is not a tale for the faint hearted or those of a nervous disposition. The catalogue of events of recent years would be divided into sections with headings like: temporary closures, permanent closures, short time working, lower production, lower demand, lower prices, fierce competition, more new capacity coming on stream, and yet more new capacity planned for the future. Looking first at the reasons behind the low demand one can immediately point to the general industrial recession in the Western World. But one needs to look much further than this to understand the full extent of magnesia's chronic problems.

The major use for magnesia — whether it is prepared from the natural carbonate mineral, magnesite, or from the magnesium chloride contained in seawater or brines — is in refractories and as such it is highly dependent on the performance and operating practice of the iron and steel industry. The performance of the steel industry in recent years has been a dismal one and needs little further description here. Suffice it to say that the overall decline in world production between 1979 and 1982 (from 747m. to 644m. tonnes) was further reflected in the marked falls in output from the USA (127m. down to 66m. tonnes) and the EEC countries (141m. down to 111m. tonnes) and even in Japan (from 112m. down to 100m. tonnes). Changes in operating practice in the steel industry have been directly responsible for reducing specific consumption of magnesia refractories as new products and techniques have been introduced for the lining and maintenance of furnaces. These have resulted in radical increases in the lining lives of LD furnaces (basic oxygen converters) and parallel advances in electric arc operation using water-cooling of lining panels have raised the prospect of refractory consumption in this area shrinking by a factor of between five and ten.

Refractory problems

It has long been recognised (as previous articles in this magazine bear out) that the refractories industry represents a market of increasing quality and decreasing quantity. For a period during the 1960s and early 1970s magnesite was in the fortunate position of growing in both senses — in volume terms at the expense of refractories based on silica and fireclay and in quality terms as demand for the developing LD converter usage made new demands on purity, density, and other properties. During this period the high purity natural magnesites of Greece, Brazil and Turkey were developed on a massive scale and the producers of magnesia from seawater and brines sought to improve their products to match the properties of these and in some respects surpass special natural materials. Problems of density were solved by the pelletising/double-burning process and chemical adjustments to the process ensured that harmful impurities such as boron were drastically reduced and that the presence of lime and silica (virtually universal mineral impurities) were present in the optimum ratios to promote periclase crystal growth and contact. Meanwhile the more regular high-iron magnesites found increased usage in electric arc furnaces to partially counter the declining open hearth markets. Shortages and

high prices in the early 1970s (IM May '74) coupled with the extremely optimistic forecasts for future steel production being made at that time put in train a number of major expansion plans and launched a series of new seawater/brine magnesia projects. The new magnesia capacity came on stream but of course steel output has subsequently fallen well below those original targets. Furthermore the quantity used per tonne of steel melted has fallen drastically, from levels of around 15-20 kilograms per tonne (kg/t) in the early 1970s to the 2-6kg/t range in West Germany and 1.5-2kg/t in Japan of today. Lining lives that were measured in terms one or two hundred heats in the early 1970s are now commonly in the 1,500-2,500 heats range in Japan and around 5,000 heats in the USA, and have on occasions been recorded at over 10,000 heats. In Western Europe lining lives measured in thousands of heats have also been recorded although averages tend to be in the 300/800 heat range, mainly because of the use of dolomite or mixed magnesia and dolomite linings. The ready availability of lower priced dolomite (often at one quarter the price of magnesite) has meant that there has always been a strong rivalry between the two products in Europe — in contrast to both the USA and Japan. When furnace downtime becomes a way of life (as it has in recent years) dolomite's shorter working life is less of a problem. Conversely when maximum capacity operating is required of a converter the choice of material must always veer towards top quality magnesite. Dolomite actually affects magnesia consumption in LDs in two ways — both as a rival lining material and in its role as a flux where dolime slag conditioner is claimed to significantly reduce refractory wear.

Electric arcs

Undoubtedly the most important development affecting electric arc furnaces during the past decade has been the introduction of water-cooling. First developed in Japan during the early 1970s the practice of running ultra high power (UHP) furnaces with water-cooled sidewall panels is now being introduced to North American and European steel plants. Although magnesia-based refractories continue in use in such furnaces magnesia-chrome and more recently magnesia-graphite bricks — are the prime products required for such operations the effect of water cooling is to cut drastically the quantity of refractory consumed. Furthermore the roofs of electric arcs are now also being converted to accommodate water-cooling. In Japan extensive water cooling has reduced specific consumption of refractories per tonne of steel melted from the conventional 2.6kg/t down to 0.25kg/t for sidewalls (ie. a factor of 10) and 3.4kg/t down to 0.5kg/t for roofs. Needless to say the implications for a decline in overall tonnage use of magnesia in electric arcs are enormous.

Other refractory fields

It should not be forgotten of course that open hearth furnaces still represent an important market for magnesia, not only in Eastern Europe and the Third World but countries such as the USA and West Germany still maintain significant capacity. However, the open hearth refractory requirements are at the

* Brian M. Coope is a former editor of *Industrial Minerals* now working as an independent industrial minerals consultant.

lower quality, lower value of the magnesite range and furthermore production by open hearth will continue to decline. The principal area which may see increasing magnesite usage is in the casting shop where continuous casting and secondary refining have taken over. The higher temperatures and greater agitation which are part and parcel of this new technology will lead to a temporary rise in refractory consumption in this area which will probably be followed by a fall as higher performance materials come into use. It is expected that magnesite — and particularly magnesite-graphite refractories — will gain some benefit from this move.

Caustic magnesite markets

There is normally quite a strong dividing line between the markets for natural calcined magnesites and the products of seawater or brine operations. Essentially caustic-calcined natural magnesites are used for agricultural and construction markets whereas the higher purity seawater/brines product tends to be used for most of the industrial uses. There are exceptions of course and certainly both natural and synthetic products are used by the paper industry, for instance, and in some regions such as parts of the USA the seawater product can compete in agricultural markets on grounds of cost and availability. Consuming patterns in caustic magnesite vary widely from one country to another — for instance, in the USA the general chemical/industrial sector dominates with around 60% of total consumption whereas in the UK agriculture predominates in a similar proportion, in Austria the same can be said for construction, and in Norway it is paper that dominates.

Agriculture

The animal feedstuffs sector of the agricultural market has been one of the major growth areas within the magnesite

market. This does not mean that it has been free from problems — and indeed it has suffered both severely from the bandwagon affect (in which producers suddenly all focus their efforts on one market). In Western Europe this led to a somewhat acrimonious period to which the "price war" label has been applied and to be followed by an anti-dumping action in the EEC against imports from China. (In fact both dead-burned and caustic-calcined qualities were cited and indeed North Korea was named as well as China but it is generally agreed that it was Chinese agricultural grade imports that set the ball rolling.) Although the action was not successful (see later section), the action has probably cleared the air a bit and certainly the agricultural sector has been enjoying a good year again in 1983. We hesitate to use the word "shortage" in case it sets the bandwagon in motion again, but certainly the order books of established suppliers have been full lately. The UK has traditionally provided the largest individual market but great strides have been made in other market European countries and France in particular appears to be increasing its magnesite appetite. Grades used for agricultural markets tend to have MgO contents in the 80/90% range and the impurity levels of the common impurities — CaO, SiO₂, Al₂O₃, and Fe₂O₃ — are not critical although the product must of course be free from toxic elements. Fine granular material is used for animal feedstuffs but a coarser material is preferred for fertiliser application and fine powder is used for pasture dusting.

Construction

Magnesite has long been used by the building industry to produce Sorel cement, a magnesium oxychloride cement used for floorings. Such flooring continues to be popular in central Europe, the Mediterranean area, and the Middle East. The magnesite used for this application should have low lime (which affects the cement setting) and low iron (for reasons of colour).

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The other main constructional use of magnesia is in lightweight, fireproof insulating boards. The Austrian producer, OEAMAG, is the prime mover in this field and manufactures its "Heraklith" board from mixtures of caustic magnesia, magnesia flue dust (the by-product of burning operations), magnesium sulphate, wood chips, and polystyrene at factories in Australia, West Germany, and Greece.

Industrial uses

The main industrial uses of caustic-calcined natural magnesites tend to be in paper (where it is used to make magnesium bisulphate lye used in the "magnefite" process), certain chemical and water treatment uses, and for the production of fused magnesia. In the latter case the magnesia content needs to be high (92/93%) and silica, iron, and sulphur must all be low. In fact there are only three producers of any size producing fusing grade magnesia — MTM and Grecian Magnesite in Greece and Comag in Turkey — and each starts with pure selected natural magnesites and use wood for fuel in the calcining process to prevent the introduction of sulphur that is inevitable when using coal or fuel oil. Fused magnesia is produced by the likes of Thermal Syndicate and Universal Abrasives in the UK and Sofrem in France for the production of electric heating elements and associated parts. Paper manufacturers can use both natural and synthetic caustic magnesia although natural material must be low in silica and iron. The Norwegian seawater magnesia producer, Norsk Hydro, has made a particular speciality of producing paper grade product and its 25,000 tpa output is aimed almost entirely at this sector notably in Scandinavia but also in West Germany and France. Steetley is also an important supplier to the paper industry as are the two Dutch companies, MAF and Van Mannekus. Magnesia is also used in grinding wheels as a binder to hold the abrasive grains in the form of a cement (Sorel-style).

The other main uses of seawater magnesias are in chemicals, where magnesia provides the starting point for a range of magnesium chemicals, and in the rubber and plastics industry where it is used in the processing of neoprene rubber and rayon. Magnesia is also used in environmental control either as boiler fuel additive or as a stack gas scrubber where its essential role is to remove sulphur and in water treatment where it acts as a neutraliser in a similar way to lime or dolime.

Production

To arrive at a figure for total world production of natural magnesite requires a high degree of guesswork, mainly because the four largest producers — the USSR, Czechoslovakia, China, and North Korea — are all Eastern Bloc countries for which reliable statistics are not easily obtained. Total crude output from these countries is estimated to be around 11m. tpa. Western World production was around nearly 6m. tonnes in 1979 but was probably nearer 5m. tonnes in 1982. Total Western World production on capacity for dead-burned natural magnesite is currently around 2.25m. tpa and of caustic-calcined natural magnesite is currently around 650,000 tpa. Total magnesia capacity from Western World seawater and brine plants is of the order of 2.2m. tpa. Most of this latter capacity is used to produce dead-burned magnesia (periclase) for refractory usage and it is difficult to be too precise on what proportion is for caustic-calcined magnesia since many of the large plants are flexible (theoretically they are 100% flexible because caustic calcined magnesia is an intermediate product in the seawater periclase process). However, it is estimated that around 250/300,000 tpa of caustic calcined magnesia from seawater and brines is produced for sale from seawater and brines in a normal year. The accompanying tables of world natural magnesite production and of Western World magnesia capacity highlight the dominant producing countries. Principal Western World producers of natural magnesite are Austria and Greece followed by Spain, Turkey, and Yugoslavia in Europe; Brazil, the USA, and Canada in the Americas; and India in Asia. The major seawater producers are located (in approximate order of size) in the USA, Japan, the UK, Italy, Mexico, Ireland, the Netherlands, and Israel.

Western World magnesia capacity ('000 tonnes)

	Natural		Seawater/brines		
	DB	CC	DB	CC	Total
Austria	510	95 (+35 dust)	—	—	605
Greece	520	—	—	—	650
Ireland	—	—	100	+	100
Israel	—	—	40	+	40
Italy	—	25	185	+	210
Netherlands	—	—	100	+	100
Norway	—	—	—	25	25
Spain	70	95	—	—	165
Turkey	172	40	—	—	212
UK	—	—	200	+	200
Yugoslavia	250	20	—	—	270
Total Europe	1,522	405	625	25	2,577
USA	100	130	577	225	1,032
Brazil	340	20	—	—	360
Canada	60	100	—	—	160
Mexico	—	—	170	+	170
Total Americas	500	250	747	225	1,722
Japan	—	—	575	+	575
India	140	20	—	—	160
Australia	15	10	—	—	25
S. Africa	60	—	—	—	60
Grand Total	2,237	685	1,947	250	5,119

Key: DB — Dead-burned, CC — Caustic-calcined + Total capacity of plant is shown under DB but caustic-calcined grades are also produced in significant tonnages

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MAGNESITE

Crude and Caustic Calcined

Country		1976	1977	1978	1979	1980	1981
Greece	—crude	1,284,000	1,358,805	1,058,211	1,667,666	1,166,998	*930,000
	—caustic	53,000	87,000	92,000	142,000	86,000	n.a.
	—dead-burned	376,000	389,000	307,000	892,000	267,000	n.a.
Austria	—crude	927,000	1,003,041	982,320	1,103,649	1,318,156	1,158,852
	—caustic	92,000	92,000	100,000	89,000	96,000	
	—caustic dust	33,000	81,000	26,000	32,000	36,000	106,000
	—dead-burned	401,000	372,000	421,000	423,000	427,000	361,000
Czechoslovakia	—crude	* 2,500,000	* 2,500,000	* 2,500,000	* 2,500,000	* 2,500,000	*2,500,000
	—dead-burned	654,000	661,000	658,000	654,000	666,000	664,000
Poland		26,000	24,000	23,746	20,010	19,610	11,282
Soviet Union		3,600,000	*3,700,000	*3,800,000	*3,900,000	*4,000,000	*4,200,000
Spain		349,000	421,241	306,548	381,867	505,532	*500,000
Turkey		409,000	516,162	418,002	729,876	825,766	772,996
Yugoslavia		491,000	345,000	333,000	293,000	262,000	300,000
South Africa		63,000	49,219	37,407	65,336	78,808	56,557
Zimbabwe		95,000	54,204	65,756	84,495	78,217	60,194
Canada	—dead-burned	40,000	*42,000	40,356	52,553	*59,000	*60,000
Brazil	—crude	415,000	481,000	410,000	591,000	729,000	*800,000
	—dead-burned and caustic	196,000	205,719	217,270	265,671	315,851	*350,000
USA	—crude	*300,000	*300,000	*300,000	*300,000	*250,000	*250,000
China		*1,000,000	*1,500,000	*1,800,000	*2,000,000	*2,000,000	*2,000,000
India		380,000	402,007	414,166	392,211	385,104	453,410
North Korea		*1,500,000	*1,500,000	*1,600,000	*1,800,000	*1,900,000	*1,900,000
Australia		15,000	18,531	21,350	29,301	32,198	26,887
World total	—crude	13,500,000	14,350,000	13,900,000	15,950,000	15,000,000	16,100,000

Notes: Adapted from Institute of Geological Sciences figures

Small production (less than 10,000 tpa of crude magnesite) is recorded from Bulgaria, Egypt, Kenya, Tanzania, Iran, Pakistan, New Caledonia, New Zealand, Argentina, Colombia, and Uruguay.

*denoted estimated figures. n.a. = not available

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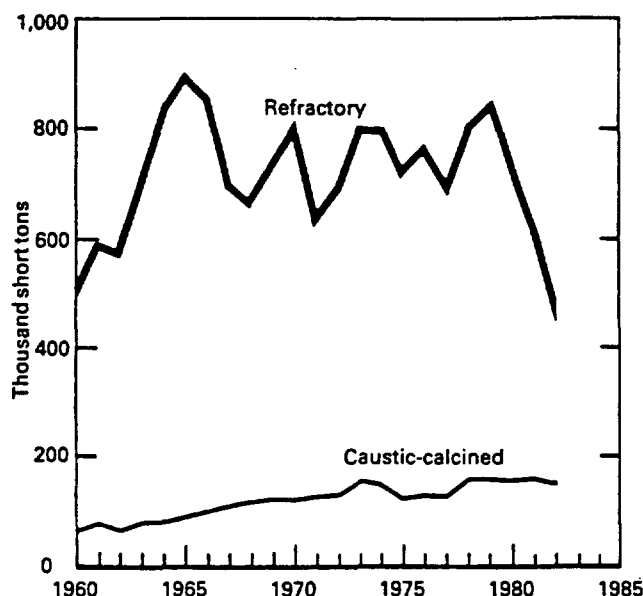
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Trade

Magnesite enters international trade in quite a big way and in an average year over 2m. tonnes of dead-burned and caustic-calcined magnesia is shipped across international boundaries. Much of this traffic takes place over distances measured in thousands rather than hundreds of miles and in certain cases — Chinese and European North Korean shipments to Europe — the material travels half the globe. Another interesting feature of the trade concerns the number of countries that are both large importers and exporters of magnesia, a consequence of the wide range of magnesites and magnesias available. For instance, Austria exports caustic-calcined and high iron dead-burned magnesites and imports similar tonnage of high purity natural magnesites from Greece and Turkey and high purity seawater magnesias from Israel and Italy; Italy exports seawater magnesia but imports natural magnesites from



Consumption and shipments of magnesia in the United States

Source: USBM

Greece and Austria; the UK also exports seawater magnesia but imports mainly caustic natural magnesite from Spain, China, and Greece. Japan is a major exporter of seawater magnesia to Far East countries yet imports large tonnages of natural product from China and North Korea. The USA exports (mainly to Canada) but also imports large tonnages from Ireland, Greece, and — more recently — China.

Developments

The European market

An extensive collection of import and export statistics appears at the end of this article but the accompanying trade matrix (based on average yearly tonnages for 1979-82) helps to highlight some of the main elements of trade. The figures are for dead-burned and caustic magnesias of both natural and seawater/brine origin and although some countries split up their trade into the different categories there tend to be so many misclassifications that it is much more accurate as well as more simple to view them as total figures. It is immediately apparent that the Western European scene is dominated by Greece as an exporter and West Germany as an importer, a fact which should cause no surprise particularly when one considers that West Germany has no production of its own. The effects of recession are clearly drawn in Greece's export figures in recent years. Although 1982 figures are not yet available Greece's exports fell from a record total approaching 500,000 tonnes in 1979 to only 280,000 tonnes in 1981. Another major exporter, Italy, has a similar tale to tell with its exports apparently crashing from 150,000 tpa in 1979 to less than 50,000 tonnes in 1982. The UK's exports seemed to peak in 1980 at a total of 80,000 tonnes but were down to less than 40,000 tpa in 1982. Other countries such as Spain, Ireland, and Israel tended to hold their own (even if Ireland's steady 70,000 tpa plus in recent years hides the fact that one producer was phasing in and other phasing out). Actual increases in exports during the period under review were recorded by Austria whose 1982 tonnage was boosted by a sudden movement of material to Venezuela and most significantly of all by Turkey, whose 1979 exports grew from 40,000 tonnes in 1979 (admittedly a poor year for the country) to 115,000 tonnes in 1982 (with the USSR emerging as a major new customer).

Among the major importers the most significant drop in tonnage was recorded by the UK with 1979's total of 145,000 tonnes falling to below 90,000 tonnes in 1982. This was undoubtedly due to a rapid decline in purchases of Italian and Greek dead-burned magnesia and certainly in the case of Italy reflects the UK's domestic producer, Steetley, producing its own LD grade magnesia rather than merely marketing a similar product manufactured by its former subsidiary in Italy, Sardamag. The other major trend to appear in the import statistics concerns the increasing tonnages of Chinese and North Korean magnesite appearing not only on European markets but in the USA and Japan too. Indeed, these large tonnages and their low prices have caused China and North Korea to be cited in an anti-dumping action brought before the EEC Commission by the Greek magnesite producers.

Western European magnesia trade — dead-burned and caustic, natural and seawater/brine grade

Average yearly tonnages in '000 tonnes for the 1979-82 period

Importers		WG	UK	Fr	Ita	Neth	Be-L	Ire	Den	Swe	Nor	Fin	Aus	Spa	Yug
Exporters	TOTAL	360	105	108	88	62	20	30	13	20	5	15	110	67	49
Greece	394	96	32	30	60	23	1	6	—	2	—	—	17	32	35
Italy	102	23	15	5	XX	8	3	—	—	—	—	—	26	15	1
UK	55	14	XX	7	—	—	3	7	—	2	—	—	—	4	—
Netherlands	28	13	2	4	—	XX	2	2	—	—	—	—	—	2	—
Ireland	64	5	8	—	2	—	4	XX	—	—	—	—	6	1	—
Austria	132	35	1	13	12	7	2	—	5	1	2	—	XX	—	—
Spain	94	27	25	14	—	5	—	5	3	3	—	2	—	XX	—
Czechoslovak	356	42	—	—	—	—	1	—	1	2	—	—	—	—	—
Israel	33	10	3	—	—	—	—	—	—	—	—	—	22	—	—
Turkey	78	—	1	—	—	5	—	—	—	—	—	—	28	—	5
Yugoslavia	27	2	—	—	4	—	—	—	—	—	—	—	—	—	XX
USA	83	12	—	2	—	—	—	—	—	—	—	—	2	—	—
Japan	113	6	4	—	—	—	—	—	—	—	—	—	—	—	1
China	n.a.	37	12	4	3	16	—	9	1	—	—	3	1	—	—
N. Korea	n.a.	28	1	1	—	—	—	—	—	—	—	—	—	3	—

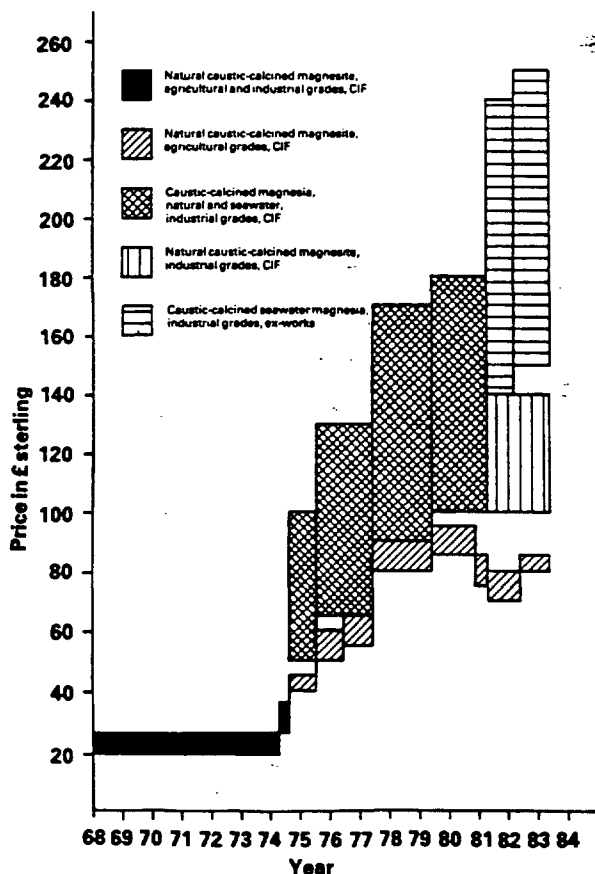
Provisional duty removed

The EEC Commission started investigating allegations of dumping of magnesite from China and North Korea during mid-1982 after complaints from Greek producers, and by the end of December came down in favour of imposing an anti-dumping duty. The duty, which effectively pegged prices on a CIF basis down to £80 per tonne for caustic-calcined magnesite and £93 per tonne for dead-burned magnesite, was provisional in nature and set to run for a period of six months. Meanwhile the Commission continued its investigation in order to present further evidence before the Council of Ministers (for details up to this point read IM Feb. '83 "Comment"). This evidence tended to confirm the existence of dumping and the Commission therefore recommended that the provisional duty be made definitive. The Council duly met in mid-June and discussed magnesite for an hour and a half but could not agree on the procedures to be adopted. It seems likely that West German and the Benelux countries opposed the imposition of definitive duties and that there was, therefore, an insufficient majority. With no decision the provisional duty therefore lapsed when the official six months ran out on June 30 and therefore all duties paid by importers during the period were returned. So what happens now? No one seems to have a definitive answer because this case is evidently setting a precedent. There seems little doubt that the market will remain under the microscope for some time to come (perhaps the Commission has a little magnesite in its blood now) but the chance is being offered for the market itself to sort out the problem. There is already talk of the Chinese raising their prices in the next round of negotiations with the European mineral importing companies.

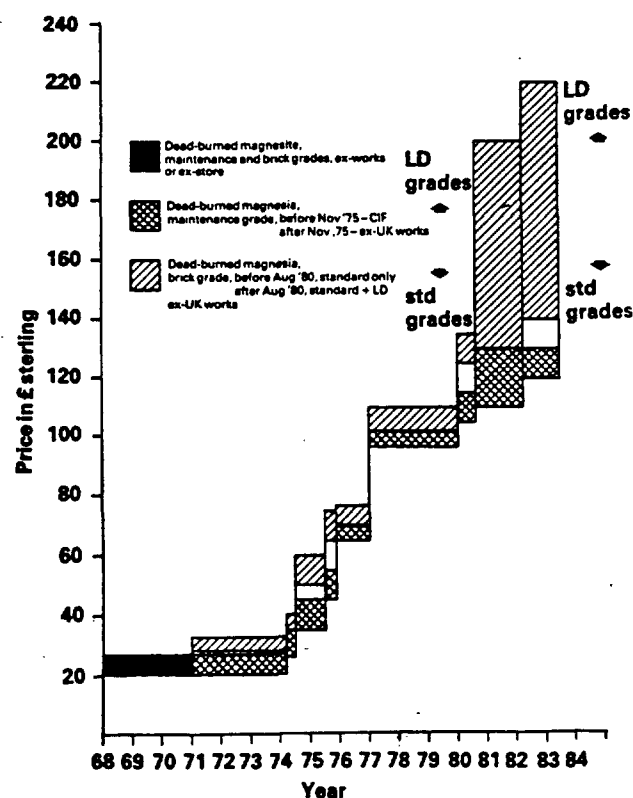
Prices

The two accompanying graphs present a simple record of price levels for the grades quoted in "Industrial Minerals" since IN records began. There are naturally broad similarities in the price movements between the two types although the price cutting exercises for the agricultural grades of natural caustic calcined magnesite show up quite clearly in contrast to the general trend. Both show the period of almost sleepy stability before the effects of the late-1973 oil prices began to bite. The 1974-77 period was one of fairly steep increases in stages and a distinct broadening of the price ranges. From the graphs it would appear that this broadening of the range was not so pronounced for dead-burned magnesite as for caustic-calcined but in fact if IM had presented a quotation for LD grades of magnesite at that time then a similar phenomenon would have been observed. Current dead-burned magnesite prices are compatible with those shown on the graph with ex-UK work prices for maintenance grades remaining in the £120-£130 per tonne range and brickmaking grain still covered by the £140-220 per tonne bracket (with LD grades top of the range). Caustic calcined magnesite prices have seen some movement in the month since the graph was drawn up:- CIF prices for agricultural grades have increased slightly at the top end of the range to give a £80-90 band (which translates to an ex-store price of £92-95 per tonne for bulk and £100-£102 per tonne for bagged material for premium agricultural material); natural industrial grades are now in the £125-200 per tonne range with fusion grades naturally enough at the top end; and caustic calcined seawater magnesite grades on an ex-UK-works basis are now in the £170-270 range. This latter price to some extent reflects change in specification as a new source of lime used by the UK operator has further improved the quality of its calcined product.

Caustic-calcined magnesite prices



Dead-burned magnesite prices



Outlook

The immediate question to be asked when discussing the future of the magnesite/magnesia market is: "Will the supply: demand balance for magnesia ever return to normal?" The answer is probably "yes, but not for a long, long time." The oversupply that exists now looks set to last for a decade, particularly in the refractory market. The steel industry in the industrialised world is undergoing such a fundamental change that there is no chance of a return to pre-1980 operating levels and the trend of reduced specific consumption of refractories previously described will undoubtedly continue. In this sector of the market then, the only conceivable route to a supply: demand balance is through more magnesia plant closures. Survivors may not just be those that produce the purest product since the multi-tiered nature of the market will ensure the survival of the natural magnesite industry as processing costs and energy conservation come under increasing scrutiny. Meanwhile in the caustic magnesia market, optimism reigns in certain sectors. There appear to be clear opportunities for growth in the agricultural sector but the benefits to suppliers will be limited if everyone fights over the mature markets rather than helping to develop new ones. Some of the more esoteric uses for the purer grades of magnesia also look set to grow although the tonnages involved are small in relation to the total market. Certainly the general industrial sector could do with a "new use" to boost consumption. The environmental sector (covering fuel, waste, and water treatment) has disappointed in this respect and there is no obvious successor. One Japanese magnesia producer was probably speaking for others in the industry when he summed up his view of the future thus: "At the bottom of patience is Heaven."

The importers

	1979	1980	1981	1982
Ireland				
Greece	10,034	5,156	76	14,254
UK	9,589	6,317	4,778	3,837
Netherlands	—	—	15	7,250
Spain	3,370	4,556	5,186	5,044
China	5,431	15,967	9,437	5,458
Total	29,776	32,116	19,816	37,114

West Germany

Greece	113,667	118,268	89,604	75,215
Italy	31,684	26,371	17,349	21,566
UK	6,185	14,874	17,120	17,640
Netherlands	11,893	9,597	12,500	13,759
Ireland	2,500	3,340	7,649	12,156
Austria	42,726	42,871	33,461	28,622
Spain	27,188	19,757	17,712	13,714
Czechoslovakia	28,120	33,278	35,609	34,644
Israel	10,490	6,439	12,049	11,058
USA	25,714	45,665	21,317	3,977
China	19,546	43,822	42,459	43,514
N. Korea	41,145	31,472	11,795	27,990
Japan	3,759	7,018	7,368	7,934
Total	373,291	407,976	335,765	319,461

United Kingdom

Greece	50,956	21,523	25,708	28,514
Italy	22,033	13,526	6,102	65
Netherlands	1,800	2,600	4,742	2,408
Ireland	—	10,208	16,111	4,832
Austria	—	1,100	1,428	601
Spain	29,788	22,523	25,708	28,514
Turkey	—	—	1,450	1,820
Israel	3,453	3,500	1,308	1,401
China	11,670	9,267	10,360	16,707
N. Korea	3,863	1,100	—	—
Japan	12,647	3,200	125	331
India	—	—	625	1,766
Total	145,260	94,177	95,703	86,738

France				
Greece	36,604	33,085	31,434	n.a.
Italy	8,253	12,286	11,050	n.a.
Netherlands	4,118	3,745	5,430	n.a.
UK	6,478	9,255	5,555	n.a.
W. Germany	4,404	2,728	5,380	n.a.
Austria	9,979	10,862	13,645	n.a.
Spain	12,972	17,824	21,045	n.a.
Norway	1,955	1,630	1,273	n.a.
Turkey	—	646	1,265	n.a.
USA	933	3,328	3,538	n.a.
China	2,300	3,130	6,022	n.a.
N. Korea	1,003	611	1,566	n.a.
Total	98,358	115,540	110,636	n.a.

Italy

Greece	59,924	77,618	37,596	51,196
Ireland	4,652	4,785	—	2,000
W. Germany	—	1,791	2,013	—
Austria	10,320	13,452	12,577	25,432
Yugoslavia	3,915	3,814	1,956	—
Czechoslovakia	1,749	—	—	—
Turkey	—	—	2,000	—
China	—	—	8,701	—
Total	82,903	108,661	72,034	70,573

Netherlands

Greece	32,420	21,579	17,231	15,500
Austria	6,677	7,432	4,718	6,559
Spain	1,953	4,415	3,323	6,166
Turkey	—	—	3,728	6,078
China	6,679	18,775	18,630	21,530
USSR	6,922	8,568	3,458	2,302
Total	62,711	68,356	54,815	59,874

Belgium-Lux.

Greece	4,692	—	—	1,164
Netherlands	2,921	2,118	1,574	1,480
UK	3,253	4,513	1,810	1,981
Italy	5,859	7,324	5,769	2,776
Austria	—	2,163	1,638	2,645
Spain	—	—	—	1,137
Czechoslovakia	1,560	1,720	1,880	741
China	—	—	—	1,051
Total	23,340	22,148	16,166	16,813

Denmark

Austria	7,333	6,883	4,873	n.a.
Spain	3,274	3,795	2,409	n.a.
Czechoslovakia	3,150	—	—	n.a.
China	1,571	2,068	903	n.a.
Total	17,639	13,873	8,932	n.a.

Sweden

Greece	5,369	—	n.a.	n.a.
UK	2,303	2,084	n.a.	n.a.
Austria	1,085	2,062	n.a.	n.a.
Spain	3,258	3,771	n.a.	n.a.
Norway	6,630	6,033	n.a.	n.a.
Czechoslovakia	2,094	3,341	n.a.	n.a.
Total	22,672	20,584	n.a.	n.a.

Norway

Austria	2,356	1,787	1,674	n.a.
China	700	1,833	—	n.a.
Total	6,030	4,508	3,840	n.a.

Finland

USSR	7,928	8,756	n.a.	n.a.
Spain	1,716	2,868	n.a.	n.a.
China	3,079	2,531	n.a.	n.a.
Total	15,379	15,865	n.a.	n.a.

Austria				
Greece	20,138	23,139	11,532	18,258
Italy	30,252	25,854	25,299	22,588
Ireland	—	3,450	9,142	11,046
Turkey	34,527	31,863	20,246	20,672
Israel	20,545	27,931	20,858	16,790
Norway	3,432	4,296	4,544	868
USA	—	5,276	3,969	—
Mexico	—	2,034	3,424	1,974
China	505	—	558	3,536
Total	113,182	125,512	104,440	99,693

Spain				
Greece	24,950	37,829	35,688	n.a.
Italy	17,819	14,232	25,307	n.a.
UK	4,417	8,329	4,048	n.a.
Netherlands	1,181	3,249	1,195	n.a.
N. Korea	2,298	4,257	4,470	n.a.
Ireland	—	1,960	—	n.a.
Total	52,550	71,481	78,660	n.a.

Yugoslavia				
Greece	32,438	37,830	34,980	n.a.
Italy	—	—	3,639	n.a.
Turkey	4,000	4,706	6,918	n.a.
Norway	3,460	2,590	4,656	n.a.
Japan	1,000	—	2,000	n.a.
N. Korea	—	—	5,000	n.a.
Total	41,650	46,197	58,665	n.a.

Japan				
N. Korea	79,474	104,319	121,076	88,193
China	37,897	68,678	76,087	160,460
Total	122,137	180,721	200,111	252,123

USA				
Ireland	44,221	45,128	37,064	30,734
Japan	21,016	9,879	17,765	854
Greece	11,634	15,300	15,965	20,471
Brazil	5,699	926	15,823	2,492
Israel	2,113	—	—	—
China	—	—	2,248	15,650
Turkey	1,019	—	—	—
Canada	1,292	2,288	535	1,495
Total	90,167	77,327	91,858	75,832

Canada				
USA	69,935	64,628	60,000	55,000
W. Germany	6,606	5,071	5,000	4,000
Total	99,573	76,596	65,000	59,000

The exporters

	1979	1980	1981	1982
Greece				
Canada	3,360	4,300	5,170	n.a.
USA	5,432	15,122	4,355	n.a.
Austria	21,541	21,402	6,460	n.a.
France	23,833	25,674	25,696	n.a.
W. Germany	97,673	107,001	71,449	n.a.
Ireland	9,896	5,094	40	n.a.
Italy	70,359	74,179	40,841	n.a.
Netherlands	38,373	21,372	12,610	n.a.
Spain	24,365	37,930	28,032	n.a.
UK	45,921	21,732	23,650	n.a.
E. Germany	650	5,780	520	n.a.
Czechoslovakia	1,800	1,290	59	n.a.
Hungary	9,968	9,547	2,331	n.a.
Romania	—	1,000	3,000	n.a.
Yugoslavia	29,400	40,640	37,502	n.a.
S. Africa	18,650	7,325	6,300	n.a.
Mexico	35,750	16,250	10,500	n.a.
India	25,801	5,510	—	n.a.
Total	476,813	423,809	280,863	n.a.



Italy				
W. Germany	31,075	25,344	11,261	—
UK	20,953	15,275	6,101	—
Netherlands	8,200	16,121	16,770	20,530
Austria	29,190	30,474	21,370	19,130
Spain	15,090	12,870	9,196	5,181
S. Africa	11,275	14,900	17,620	—
Poland	14,650	—	—	—
Canada	12,700	4,200	—	—
Total	154,439	119,610	88,602	46,190
Ireland				
UK	600	9,124	14,937	5,504
Belgium-Lux	—	4,330	8,882	17,495
W. Germany	260	3,382	6,062	5,702
Italy	951	1,919	—	2,350
Austria	—	3,450	6,990	10,970
Spain	—	2,010	980	1,318
Poland	—	500	—	1,000
USA	33,861	45,134	37,035	26,546
Total	35,901	73,395	77,361	70,861
United Kingdom				
W. Germany	13,200			
France	7,500			
Poland	8,700			
Ireland	6,800			
S. Africa	4,700			
Belgium-Lux	3,200			
Venezuela	2,800			
Portugal	1,900			
Sweden	1,600			
Total	65,000	80,000	39,600	36,400
Netherlands (caustic-calcined only — dead-burned withheld)				
W. Germany	14,164	11,773	13,870	14,351
France	4,016	3,473	3,651	4,748
Belgium-Lux	2,948	2,094	1,525	1,550
Spain	1,231	1,803	1,414	796
UK	1,587	862	1,049	585
USSR	990	—	940	1,485
Total	30,556	26,887	26,169	28,001

WITHHELD

Austria				
W. Germany	n.a.	40,348	32,497	27,854
Italy	n.a.	12,917	10,673	9,990
Belgium-Lux	n.a.	2,360	2,179	1,908
France	n.a.	11,455	12,974	16,302
Netherlands	n.a.	7,640	5,138	6,801
Switzerland	n.a.	2,872	3,236	3,078
Sweden	n.a.	1,116	1,844	1,993
E. Germany	n.a.	3,098	1,998	571
Poland	n.a.	32,546	4,578	—
Hungary	n.a.	13,340	12,194	11,787
Egypt	n.a.	1,064	2,038	2,825
Argentina	n.a.	1,500	1,454	3,308
Venezuela	n.a.	1,064	—	16,689
USSR	n.a.	—	—	4,800
Total	111,345	137,837	96,636	160,567

Czechoslovakia				
Hungary	82,000	82,000	73,000	n.a.
Poland	58,000	70,000	62,000	n.a.
E. Germany	62,000	55,000	57,000	n.a.
Romania	41,000	37,000	20,000	n.a.
W. Germany	58,000	61,000	38,000	n.a.
Total	377,000	385,000	305,000	n.a.

Spain				
W. Germany	43,652	33,588	24,193	n.a.
Denmark	3,150	3,110	3,025	n.a.
France	4,520	12,893	15,599	n.a.
Ireland	4,435	6,155	8,425	n.a.
Netherlands	7,931	5,218	3,096	n.a.
UK	24,209	20,114	23,374	n.a.
Canada	1,412	—	1,433	n.a.
Sweden	803	3,688	1,300	n.a.
Belgium-Lux	—	—	55,584	n.a.
Venezuela	—	—	5,860	n.a.
Total	93,459	91,166	98,750	n.a.

Yugoslavia				
USSR	—	7,126	20,607	n.a.
Italy	3,783	4,052	4,812	n.a.
Hungary	3,212	2,948	2,047	n.a.
Poland	16,994	5,875	1,565	n.a.
W. Germany	3,589	2,762	—	n.a.
Total	28,182	24,218	29,310	n.a.

Turkey				
Austria	33,920	31,370	20,195	n.a.
Netherlands	3,560	4,013	13,391	n.a.
USSR	—	25,500	60,630	n.a.
Yugoslavia	—	6,970	5,000	n.a.
India	—	4,000	2,500	n.a.
UK	—	—	2,150	n.a.
Italy	—	—	2,000	n.a.
Switzerland	—	—	8,000	n.a.
Total	41,506	77,840	115,605	n.a.

Israel				
Austria	—	18,785	24,466	n.a.
W. Germany	—	8,123	4,666	n.a.
UK	—	3,288	2,356	n.a.
USA	—	2,100	—	n.a.
Total	—	33,344	32,407	n.a.

Brazil				
Argentina	7,020	7,010	4,505	n.a.
Chile	2,320	4,020	2,120	n.a.
India	10,000	19,550	—	n.a.
Mexico	7,000	3,000	—	n.a.
Netherlands	2,000	1,050	—	n.a.
Peru	3,304	7,875	6,003	n.a.
Poland	60,650	34,772	72,055	n.a.
USA	5,700	—	15,500	n.a.
Venezuela	5,500	8,500	5,000	n.a.
S. Africa	—	3,000	—	n.a.
Total	104,399	88,847	106,196	n.a.

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USA				
Canada	70,103	44,989	54,898	33,065
Argentina	4,456	5,776	1,228	1,107
Venezuela	5,025	27,031	28,637	3,133
France	1,011	3,082	3,756	3,002
Australia	824	3,856	2,920	2,440
Belgium-Lux	1,077	264	3,566	967
Total	91,979	90,075	100,289	48,702

Japan				
S. Korea	12,488	20,157	19,839	24,785
Taiwan	13,670	11,008	8,187	6,253
Thailand	4,780	7,015	3,650	—
Philippines	4,458	3,868	2,637	3,593
Indonesia	1,765	1,889	1,935	3,035
Netherlands	—	7,000	10,600	6,500
Yugoslavia	3,000	—	5,000	—
USA	24,676	6,470	10,084	1,846
Venezuela	3,150	4,850	7,500	3,000
S. Africa	6,936	10,141	4,459	2,882
Australia	22,815	19,058	14,540	10,424
UK	9,500	—	—	—
Belgium-Lux	6,750	—	—	—
France	6,231	—	—	—
Poland	8,000	17,000	—	—
USSR	—	150	650	28,648
Total	138,299	119,262	94,346	101,427

Magnesia producers — a review of recent developments

Any review of production development within the past few years must begin with Western Europe and the Mediterranean area. (The addition of the latter is to allow both the Turkish and Israeli operations to be included for despite both being geographically in Asia they are both also very much in Europe so far as the philosophy and commercial reality of the magnesia market is concerned.) The region has not only seen the greatest expansion of capacity in the past decade, but continues to be a large importing region and consequently represents the most varied and fiercely competitive market in the world — and many would say that for this reason it will also be the scene of the most interesting shake-out in the future. The post 1973 period has seen the introduction of new seawater/brine plants in Israel (*Dead Sea Periclase* in 1974), Italy (*Cogema* in 1975), Ireland (*Premier Periclase* in 1980), and the Netherlands (*Billiun's Magnesia International* in 1981) and new projects based on natural magnesite appeared in Turkey (*Kumas* in 1976) and Greece (the *Bodossaki/Papastratis* joint venture which opened in 1977 but closed permanently the following year). Apart from the

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latter the only closure of note saw the demise of the Quigley seawater magnesia plant at Dungarvon in Ireland in 1981. Three other European seawater magnesia projects reached an advanced planning stage before final abandonment: these were the 200,000 tpa plant of *Norsk Hydro* at Bodö in northern Norway, the 100,000 tpa seawater plant proposed by the *Scalstiri* group on the island of Euboea in Greece, and the *Magnohrom* project to build a 100,000 tpa plant on the Adriatic coast, south of Dubrovnik in Yugoslavia. Other projects were also noted for Spain, Portugal and France (and probably in other countries too) but in these cases plans never appeared to reach an advanced stage. More plans are now in the pipeline for that other part of the Mediterranean area — the Arab World — but more of that after a closer look at established production in the region.



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Seawater plants — start with Steetley

There are now seven seawater or brine plants operating in the European/Mediterranean region with a total magnesia capacity of 650,000 tpa. Apart from the Norsky Hydro plant at Porgrunn, which produces only caustic magnesia all other plants produce a preponderance of dead-burned magnesia and the percentage output of caustic magnesia produced for sale varies from 1% to 15% from one plant to another. Maturity is not the only issue involved but certainly the older plants have been able to develop a substantial output of caustic grades to supply established customers in a wide range of industries. This is patently true of the *Steetley Refractories* seawater magnesia plant at Hartlepool in north-east England. If the county in which it is now domiciled — Cleveland — is still striving for recognition then the plant itself has no such problems. The Hartlepool plant was the world's first commercial plant for the production of refractory magnesia from seawater and the Steetley group has been responsible for many of the subsequent developments that have lifted the seawater magnesia industry to its current state of refinement. Today the plant is capable of producing up to 200,000 tpa of both dead-burned and caustic calcined grades of magnesia to cover the full spectrum of refractory uses as well as a wide range of industrial applications. When the demand for high purity, high density magnesia first took off the Steetley Co. applied its technology to producing the material in Sardinia in Italy where the nearby occurrence of high purity limestone ensured an exceptional quality magnesia product. For many years Steetley retained a 30% interest in *Sardamag*, the Sardinian producer, in conjunction with *Didier-Werke* of West Germany and Italian interests. At the same time Steetley divested its interest in *Sardamag* as it developed its own LD grades at Hartlepool by using high purity domestic limestone instead of the less pure

dolomite from Thrislington which had been the staple diet of the Hartlepool plant throughout its early years.

Italy — Sardamag and Cogema

Italy rose to prominence as a seawater magnesia producer as a result of the launching of the *Sardamag* project at Sant'Antioco in the south of Sardinia in 1965 by the three joint venturers — *Steetley* of the UK, *Didier-Werke* of West Germany, and the Italian industrialist Dr. Giorgio Casari. Product from the original 60,000 tpa plant was soon in demand and an expansion was put in progress which resulted in a total capacity of 120,000 tpa by 1972. In 1976 the capital of the company was raised in anticipation of a further expansion and a fourth party, *Sanac* — the refractories producing arm of the Italian *Finsider* steelmaking group, became a 10% shareholder in the company. It was about this time that the Italy's second seawater magnesia plant came on stream at Priolo, near Syracuse on the island of Sicily. Operated by *Cia Generale del Magnesio (Cogema)*, the 65,000 tpa plant was then controlled by *Sirma*, a refractory producing member of the Fiat car-producing giant. However in 1978 *Sirma* sold 50% of the shareholding to *Sardamag* and a further 25% to the Austrian magnesite producer, *Veitacher Magnesitwerke*. Later, in 1980, *Sirma* transferred its remaining 25% interest to *Sardamag*. Today both operations produced high purity LD grade magnesia and caustic-calcined grades for use in chemicals, fertilisers, paper, feedstuffs, etc.

Mention should also be made here of Italy's modest and unassuming production of natural calcined magnesite conducted by the *Eraclit* construction materials group of *Peseggia*. The group subsidiary, *Eraclit Venier*, extracts magnesite from an open pit at Solda in Bolzano province and transports it to a main plant at Portomarghera, near Venice. A number of grades of raw and caustic-calcined magnesite are prepared for industry and agriculture.

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Ireland — enter Premier, exit Quigley

The *Quigley Magnesite* operation at Dungarvon in County Waterford entered production in 1970 with a capacity of 68,000 tpa and by the end of the decade this had been stretched to 95,000 tpa by a number of process improvements. However, the 91% MgO product produced by the company began to lose many of its export markets as more and more higher performance magnesias came onto the market and the plant was closed permanently in 1982. Quigley, which is a subsidiary of *Pfizer Inc.* of the USA, continues to produce refractory specialities in Ireland but now uses imported magnesite.

Despite the Quigley closure Ireland remains very much in the forefront of seawater magnesia production through the operations of a newer producer, *Premier Periclase*. This company was set up as a joint venture between *Cement Roadstone Holdings* of Ireland and the UK's largest refractories manufacturer, *GR-Stein Refractories* (which subsequently withdrew from the venture during 1982 to leave *Cement Roadstone* as sole owners). The 100,000 tpa plant at Drogheda in County Meath was actually converted from an inoperative wet-process cement plant to which sophisticated trappings have been added. It entered production at the end of 1980 and needless to say it was an unfortunate time to try to enter the market and in common with many other producers, Premier had to temporarily close down the plant (in late 1982 and early 1983). Since reopening in April the plant has run close to full capacity and production is likely to reach 60,000 tonnes for this year. The company produces one high purity magnesia for conventional refractory use and two low boron LD grade products and is also starting to produce small quantities of caustic magnesia for sale.

Israel

The *Dead Sea Periclase* project is a joint venture between *Israel Chemicals*, which has for many years been extracting

potash, bromine, and salt from the brines of the Dead Sea, and the Austrian magnesite and refractories producer, *OEAMAG*. The 50,000 tpa plant to produce magnesia from magnesium chloride brine was completed at Mishor Rotem in the Negev Desert some 20km from the Dead Sea in 1974. A unique thermal decomposition process is employed (the Aman process), in which magnesium chloride reacts with water vapour to form magnesium oxide and hydrochloric acid. Washing the oxide produces the hydroxide which is then converted to dead-burned magnesia in the conventional manner. Very high purity magnesias containing over 99% MgO are produced in both dead-burned (for LD and electric arc refractory applications) and caustic calcined form (for rubber, adhesives, metallic soaps, and magnesium chemicals). The plant is currently running at the 40,000 tpa level, which is considered as full capacity with the current split of grades.

Netherlands — the Billiton venture

The Veendam magnesia-from-brines operation in the Netherlands was mechanically completed at the end of 1981 and commissioning proceeded into 1982. The plant is operated by *Magnesia International*, a subsidiary of Billiton Nederland, and is capable of producing well over 100,000 tpa of high purity (98.5% MgO) magnesias, predominantly in the dead-burned pelletised form for LD and electric arc usage. The company will also produce some caustic magnesia for sale in the longer term.

Norway

Norsk Hydro first began to produce magnesium metal from seawater in the early 1950s and subsequently started supplying small quantities of its intermediate process product, caustic magnesia, to local paper works. Today the company continues to make about 25,000 tpa of caustic available to papermakers in Norway, Sweden, and elsewhere.

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Austria — the pioneers

Austria's refractory magnesite industry recently celebrated its centenary and indeed during most of the last century has continued to play a major role in the development of Europe's basic refractories industry. The Austrian output is based on deposits of a high iron form of magnesite known as breunnerite. For many years this was considered to be the ideal form of refractory magnesite as the iron content helped to play a positive role in the sintering process and the refractories made from breunnerite were eminently suitable for the operating conditions of open hearth furnace. However, the more stringent operating conditions of the LD furnace required purer forms of magnesite and the Austrians were not slow to recognise the fact (after all the Austrians invented the LD furnace) and since suitable quality magnesite was not available within the country, the two main producers — *Veitscher* and *OEMAG* — both set out to secure supplies from overseas. *OEMAG* set up operations in Greece based on high purity cryptocrystalline magnesite (through its subsidiaries, *Magnomin* and *General Mining* — now combined into one unit) and *Veitscher* established a similar operation in Turkey (*Manyesit*). Subsequently both have also taken interests in seawater/brine magnesia operations — through *OEMAG*'s involvement in setting up the *Dead Sea Periclase* operation in Israel and *Veitscher*'s moving to take a shareholding in the Italian seawater magnesia producer, *Cogema*, once the *Sirna/Fiat* group withdrew its interest. Hence both *Veitscher* and *OEMAG* import material from these (and other) sources to supplement output from their own mines and enable both to offer a complete range of magnesia-based products, a major proportion of which is for export. The two companies are also both involved in caustic-magnesia production, with *OEMAG* focussing its attention on the construction market by supplying caustic magnesia and caustic flue dust (waste from dead-burning) to subsidiary companies in

Austria and West Germany for the production of 'Heraklith' lightweight building boards. *Veitscher*'s interest in caustic magnesia is pursued through its subsidiary, *Magindag*, which produces grades for agriculture (feedstuffs and fertilisers), cement floorings, abrasives, pulp and paper, and flue gas desulphurisation.

Greece — a purple patch

Greece's magnesite industry enjoyed a "purple patch" during the 1960s and early 1970s in which its status grew from not merely being an important source of caustic magnesia into a leading position as the Western World's major source of both high grade refractory magnesia as well as high grade caustic. The Austrian influence in this process has already been alluded to but the main force behind the country's rise to prominence was most obviously encapsulated in the spectacular growth of the *Scalstiri Group* with its operations centred on Mantoudi on the north east coast of the island of Euboea. After a long history as a small but important supplier of high purity crude and caustic-calcined magnesite, the group — through its subsidiary, *Société Financière de Grèce*, later to be renamed *Fimisco*, *Financial Mining Industrial & Shipping Corporation* — ventured into the refractory magnesia market in 1973 with a 10,000 tpa rotary dead-burning kiln. By 1971 new kilns had been added to raise total burning capacity at Mantoudi to over 200,000 tpa and plans were laid down for new kilns as well as a refractory brick plant, a seawater magnesia plant, a dolomite operation, and new centres of production at Ormylia in Chalkidiki and on the island of Lesbos. The 1973 oil shock and subsequent reappraisal of Western World growth naturally put the brakes on such ambitious plans and the seawater project and expansions outside Euboea were shelved. However, the company's refractory brick plant came on stream during 1973 and expansions and improvements to its Euboea operations have increased total dead-burning capacity to the current

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350,000 tpa, which includes 50,000 tpa of an extremely high purity floated natural magnesite known as "Mogaflot". This product uses a double-burning and pelletising process similar to that used by seawater magnesite producers.

The second largest magnesite producer in Greece is *Grecian Magnesite Co.*, a member of the *Portolos* group, with its operations centred in Yerakini on the Chalkidiki peninsula of the northern Greek mainland. The company also had long-established caustic-calcined origins before it entered the ranks of dead-burned magnesite produced with the installation of a 60,000 tpa kiln during 1971. The company has subsequently expanded both dead-burned and caustic-calcined capacity at Yerakini and also took over the caustic-calcining plant at nearby Kalyvia which was formerly operated by *Magnomin*. *Grecian Magnesite's* total capacity now stands at 120,000 tpa dead-burned and 85,000 tpa caustic-calcined. Meanwhile *Magnomin* continues to operate its 50,000 tpa dead-burning plant at Vavdos in Chalkidiki, Greece's remaining magnesite producer, *Mining Trading & Manufacturing*, has continued to produce high purity raw and caustic-calcined magnesite from its operations at Tamvakas, near Mantoudi, on the Euboea, and although it at one time held a share in the short-lived *MMICE-Magnesite Mining Industrial & Commercial Enterprises*, which operated a 50,000 tpa dead-burning plant on Euboea during 1977/78, the company has no current plans to enter dead-burned production.

The Americas

Activity in the Americas during the past decade has been less spectacular than in Europe — partly because the real period of expansion for the USA's magnesite industry came in the 1960s when new seawater and brine plants were added to supplement the existing natural magnesite operations. By the early 1970s

total US magnesite capacity from seawater, brines, and natural magnesite was around the 1.2m. tpa figure. Since then there have been no new plants built: the only major expansions made have been to *Martin Marietta's* brine plant at Manistee, Michigan; and there have been a number of recent closures. *Martin Marietta's* rolling programme gradually pushed the company into the position of being the USA's largest magnesite producer (with a total capacity of around 325,000 tpa of both dead-burned and caustic-calcined magnesias).

Closures at Freeport, Cape May, and Pascagoula

The *Dow Chemical Co* has for many years operated a seawater plant at Freeport, Texas, whose prime objective has been to produce magnesium metal. However, since magnesium hydroxide is an intermediate product in the process, *Dow* also produced up to 50,000 tpa of caustic-calcined magnesite for sale and also supplied magnesium hydroxide to the nearby dead-burning plants of *Lavino* (until 1974 the refractories division of *IMC*) and *A. P. Green Refractories*. The *Lavino* company was taken over by *Kaiser* in 1974 and the Freeport dead-burning plant subsequently closed. *Dow* itself ceased caustic-calcined magnesite production in early 1976 and the more recent closure of *A.P. Green's* plant means that the Freeport plant now concentrates solely on magnesium metal production. Nevertheless, *Dow* still has a part to play in the USA's magnesite industry through its brine chemicals plant at Ludington, Michigan, from which it produces bromine as well as various magnesium and calcium compounds. Among the latter the company produces a magnesium hydroxide slurry which it supplies to the nearby dead-burning plant of *Harbison-Walker Refractories*. In fact H-W's 800,000 tpa Ludington plant is now the company's sole captive source of magnesite within the USA since the recent announcement that it was closing down its Cape May, New Jersey, seawater magnesite operation as of

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31 July 1983. The other significant closure of recent years was the demise of the Pascagoula, Mississippi, seawater magnesia plant during 1981. This plant was at one time run by *H.K. Porter Co.* but ownership was transferred to *Corhart Refractories*, a subsidiary of *Corning Glass Works*, during the mid-1970s.

The big four

These developments leave total US magnesia capacity at a level of around 1m. tpa — although in recent years capacity utilisation has been low — of the order of 60%. Apart from the 40,000 tpa of capacity held by the specialist producers of high purity magnesias (including technical and pharmaceutical grade) this is now all in the hands of the four large producers — *Martin-Marietta*, *CE-Basic*, *Harbison-Walker*, and *Kaiser Refractories*. As mentioned above both *Martin-Marietta* and *Harbison-Walker* base their operations on the Michigan subterranean brines. *Kaiser's* production is based on its seawater plant at Moss Landing, California, whereas *CE-Basic* operates both a seawater plant — at Port St. Joe, Florida — and is the country's sole surviving producer of natural magnesite from its operations in Gabbs, Nevada. Of the "big four", *Harbison-Walker* produces only dead-burned magnesia and that for its own consumption in refractory manufacture; *Kaiser* is predominantly a producer of dead-burned magnesia (largely for its own use) but is an important supplier of caustic to US west coast markets; *CE-Basic* produces dead-burned magnesia at both Gabbs and Port St. Joe essentially for its own use but is a major-supplier to the free market of its caustic magnesia from both operations, and *Martin Marietta* is a major supplier to the open market of both types of magnesia and consumes only a small fraction of its dead-burned production in the manufacture of its own range of refractory specialties.

Special magnesias — Merck and Morton lead

Outside the "big four" there are five smaller magnesia producers with a total capacity of around 40,000 tpa which specialise in the smaller volume, higher purity end of the market. The largest of these is *Merck & Co.*, which produces a range of heavy and light magnesias for use in food, pharmaceuticals, rubber and plastics, and a wide range of miscellaneous industrial uses (paints, adhesives, catalysts, ceramics, oil additives, steel coatings, etc.) from its seawater magnesia operation in South San Francisco Bay in California. *Morton Chemical* produces a similar range of products from brine operations at Manistee, Michigan, and has recently undergone a major expansion to increase its overall capacity and its range of products. Two other small seawater plants run by *Barcroft Co* at Lewes, Delaware, and by *West Magnesium* at Chula Vista, California — appear to remain operational. The fifth and newest of these specialist producers is *Woodville Lime* of Ohio, which began producing high purity magnesia from dolomite (in a variation of the Pattison process) during 1981.

Canada — enter Baymag . . .

Canada has never exerted a major influence on world magnesia markets but its contribution has always been an interesting one. For many years it was the home of the world's only commercial operation producing magnesia from brucine natural magnesium hydroxide. The plant at Wakefield, Quebec, began operations in the early 1940s but was finally closed for economic reasons in 1968 by the operator, *Alcan*. A Canadian seawater plant also operated for a short time in the late 1960s and early 1970s at Aguathuna, Newfoundland, specifically designed to supply the country's pulp and paper industry. This too was closed by the owners, *Lundrigans Ltd.* for economic reasons. One operation that has continued



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Kilmar, Quebec, plant of *Dresser Industries Canada* (formerly *Canadian Refractories*), a subsidiary of *Dresser Industries* of Houston and an associate to *Harbison-Walker* of the USA. The company produces up to 60,000 tpa of dead-burned dolomitic magnesite containing approximately 60% MgO which is then shipped to the company's refractories plant at Marelán. The most significant recent development involving Canadian magnesite production was the start-up in June 1982 of the *Baymag Mines* project in Western Canada. Raw magnesite from the Mount Brussildof deposit in British Columbia is transported to a calcining plant at Exshaw, Alberta, where current operating capacity is about 60,000 tpa but is expected to reach full capacity of 100,000 tpa by 1985. At present all production is of high purity caustic magnesia averaging 97% MgO and supplied in a range of grades. Since 1979 Baymag has been a subsidiary of the West German refractories group, *Refratechnik* of Göttingen.

... and Magnaq

As if to underline Canada's determination not to conform with the rest of the magnesia industry, the first known plant to produce magnesia from asbestos waste is due to go on stream at Thetford Mines in Quebec later this year. The 6,000 tpa operation is based on the reaction between the residues (essentially serpentine) and ammonium sulphate. The magnesium sulphate product of the reaction is easily purified and is converted in a carbonation tank to magnesium carbonate, which is then calcined to yield magnesia. The beauty of the process is that the ammonia from the reactor, the sulphate from the carbonation tank, and the carbon dioxide from the kiln can all be recycled. The products will be aimed at high purity consuming industries such as pharmaceuticals, cosmetics, and rubber.

Mexico's two magnesia operations are both subsidiaries of the major industrial and mining group, *Industries Peñoles*. *Química del Mar* runs the 70,000 tpa seawater magnesia plant at Ciudad Madero, near Tampico in Tamaulipas State. The second operation, which extracts magnesia and sodium sulphate from brines at Laguna del Rey in Coahuila State, is operated by *Química del Rey*. An expansion programme to raise magnesia capacity from 45,000 tpa to 100,000 tpa is currently being commissioned.

Brazil

Brazil is the possessor of some of the best quality natural magnesite deposits in the world and has established itself as a major supplier to world markets. The main driving force behind this has been the *Magnesita* group of Belo Horizonte whose operations at Brumado in Bahia have been expanded in stages to the current dead-burned capacity of 315,000 tpa. Three main grades are produced: a 97% MgO grade (1980 output 10,000 tonnes), a 95.5% MgO grade (110,000 tonnes), and a 94% MgO grade (170,000 tonnes). A fair proportion of output is consumed in the company's own refractories plants (the company is also South America's largest refractories manufacturer). Brazil's second ranking refractories manufacturer — *Industries Brasileiras de Artigos Refratarios (IBAR)*, a member of the *Votorantim* group — also produces magnesite at Brumado and has recently installed a 25,000 tpa dead-burning kiln there which is operated by the subsidiary, *Ibar Nordeste*. Another group subsidiary, *Ceramica de Guarulhos*, operates a 18,000 tpa caustic-calcining plant at Brumado (and also once operated a similar plant in Ceara province).



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Japan — and then there were two

The brief but spectacular history of Japan's magnesia industry epitomises the fluctuating fortunes of refractory magnesia. Led by the rapid growth of its domestic steel industry, based to such a degree on the LD process, Japan's magnesia industry grew in leaps and bounds to cater for the burgeoning demand for refractory magnesia. By the early 1970s magnesia capacity in Japan exceeded 700,000 tpa and its largest producer, *Ube Chemical Industries*, had emerged as the world's largest producer of refractory magnesia with a total capacity of 450,000 tpa. With its close links with several of Japan's steelmakers, Ube was well placed to develop its products not only in quantity but quality as well and to build an important export market on top of its firm domestic base. Nevertheless the changing conditions of the past decade have had their effect in Japan too. Although Ube has retained all of its capacity at its Ube City site in Yamaguchi Prefecture, it has been operating at low capacity utilisation levels in recent years and there have been closures throughout the rest of the industry. Smaller producers such as *Hokuriku Seiel* and *Nihon Kaisui* left the scene completely (the latter in 1981) and last year the country's second largest — and indeed only other surviving — seawater magnesia producer closed down its 70,000 tpa plant at Toyama. This company — *Shin Nihon Chemical Industries*, a subsidiary of *Asahi Chemical* — now relies on its 100,000 tpa plant at Minamata and the small 20,000 tpa plant at Onahama to supply its reduced markets. Hence Japan's total seawater magnesia capacity is now 575,000 tpa. A further 20,000 tpa dead-burning capacity is also owned by *Asahi Glass* (no relation to *Asahi Chemical*) and is evidently running at full capacity at its Kitakyushiu plant.

To compound the problems of lower steel production and lower specific consumption in steel, Japan's magnesia producers are also faced with having to meet the competition of low-priced imports from China and North Korea.

India — Salem and Almora

The Salem district of Tamil Nadu in southern India has for many years been the centre of India's magnesite production and although there has been significant growth of production in other states — particularly Uttar Pradesh — it is still responsible for over 70% of the country's total output. (453,000 tonnes in 1981). Until the early 1970s Salem's production was essentially in the hands of two producers — *Dalmia Magnesite* (specialising in dead-burned magnesite production) and *Salem Magnesite* (a caustic-calcined producer). However, the 1970s saw a period of expansion for the district in which both established producers added new capacity — *Dalmia* expanding to 72,000 tpa dead-burned and *Salem Magnesite* adding a small 10,000 tpa rotary kiln to produce dead-burned product — and in which new plants were set up in the area by *Burn Standard* (a Government of India undertaking) and *Belpahar Refractories* (a subsidiary of *Tata Iron & Steel Co* — *Tiasco* in which *Didier-Werke* of West Germany also has an interest). The period also saw the increasing involvement of the Tamil Nadu State Government in the industry as it took over most of the mining leases in the area (which are administered by *Tamil Nadu Mining Corporation*) and set up the operating subsidiaries, *Tamil Nadu Magnesite Ltd.* and *Tamil Nadu Magnesite Products Ltd.* The former of these two is engaged in mining magnesite from the Kudumbpatti deposits and the latter is actually responsible for magnesite processing (dead-burning 7,200 tpa and caustic-calcining 20,000 tpa). When TNMP was first formed, (in 1979) it was as a joint venture with the old Salem Magnesite but it now appears to have become wholly-owned by the government and in the meantime Salem Magnesite has resurfaced as *Salem Refractories*, which no longer mines magnesite but buys in raw material for the production of caustic magnesia, dead-burned magnesite, and refractory bricks. The dead-burning plant of Belpahar Refractories appears to use some raw material from

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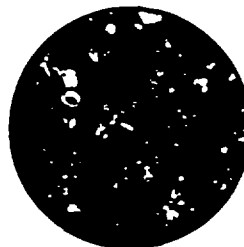
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the Tisco group mine at Mysore, just over the state border in Kamataka, and the dead-burned product is evidently sent to the company's refractories plant in Orissa.

The Uttar Pradesh magnesite mining industry has grown considerably in recent years to establish itself undisputably as the country's second largest magnesite mining region. The main momentum has come from the operations of *Almora Magnesite*, a joint venture between the *Uttar Pradesh State Industrial Development Corp*, *Belpahar Refractories* of the Tisco group, and the *Steel Authority of India*. The company operates a 24,000 tpa dead-burning plant at Matela in the Almora district which is supplied from its own mines at Jhiroli. Two smaller producers in Uttar Pradesh are *Himalayan Magnesite* and *Orissa Industries (Orind)*. Both of which operate mines only in the Pithoragarh district. At one time it appeared that Orissa Industries was intending to build a 30,000 tpa dead-burned magnesite plant at Chadak, UP, to be based on these deposits but these plans were apparently abandoned in favour of Orind's interest in the new Nepalese magnesite project.

Nepal

The Kharidunga magnesite deposit in the Dolkha district to the north east of Katmandu first came to prominence after a thorough appraisal was made in the early 1970s to establish its size and quality (see IM April 73). The first real details on the likely participants and the nature of a commercial project began to emerge in late 1979 (see IM March 79) when it was announced that a joint venture between the Nepal government and Orissa Industries of India would build a 50,000 tpa dead-burning plant at Lamusangu. Financial assistance has been supplied to the project by the *International Finance Corp* and technical assistance has been supplied by *Harbison-Walker Refractories* of the USA and by Orind which is implementing and managing the project under the joint subsidiary, *Nepal Orind Magnesite*. Start-up is scheduled for 1987.

China

China is one of the world's largest producers of natural magnesite, and its industry is based principally on the huge reserves of the Liaoning deposits in north-east China. At present three large open cast mines are in operation to provide feed to a wide range of kilns of shaft, rotary, and calcination type which together are thought to have a capacity of 700,000 tpa dead-burned magnesite and 300,000 tpa caustic calcined magnesite. A modern high temperature shaft kiln with 30-35 tpd capacity is currently being installed to produce 97% MgO high density LD grade product.

North Korea

The *Korean Magnesite Works* with its mainplant at Tanchon is currently thought to have a dead-burning capacity of around 600,000 tpa but recent reports suggest that the country is about to embark on a major expansion programme.

Southern Africa — seawater to come?

Apart from small production of caustic magnesia to serve local industries magnesite production in southern Africa is essentially controlled by South Africa's two major refractory manufacturers, *Vereeniging Refractories* and *Cullinan Refractories*. Within South Africa itself the only large scale magnesite mine in current operation is the Burgersfort, Transvaal, plant of Vereeniging's mining subsidiary, *Verref Mining*. The associated plant has a dead-burning capacity of 35,000 tpa. Vereeniging and Cullinan used to jointly operate a mine at Messina in the Transvaal through the subsidiary, *Mopar Magnesite*, but this was closed down in 1980. Meanwhile the two company's have another joint subsidiary, *Gatooma Magnesite*, mining in the Hartley district of Zimbabwe supplying crude magnesite to plants in South Africa but a further joint

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venture, *Pande Magnesite*, with operations at Beit Bridge was closed in 1977.

For many years now there has been speculation about the possibility of South Africa constructing a seawater magnesia plant and a number of the country's major industrial groups have had their name connected with past schemes. A project currently under consideration proposes to simultaneously produce magnesia and soda ash from seawater by a new but undisclosed process. The company behind the plan is *Anglovaal* and thorough investigations are understood to be in progress on several levels — financial, commercial, and technical.

Australia — re-enter Norseman?

Australia's magnesite industry has grown very gradually over the years with the prime objective of serving the country's own somewhat modest consumption of magnesia. One company — *Harbison-ACI*, a joint subsidiary of *Harbison-Walker* of the USA and *Australian Consolidated Industries* — specialises in the production of dead-burned magnesite from its 15,000 tpa plant at Fifield, New South Wales. Caustic-calcined magnesite output is the preserve of *Young Mining*, a subsidiary of *Devex*, which runs a 10,000 tpa plant at Young, New South Wales. Australia's other magnesite deposit of note which makes news from time to time is the Ravensthorpe magnesite deposit in Western Australia owned by *Norseman Gold Mines*. During the mid-1970s the Austrian company, *OEAMAG*, undertook extensive testwork on the material and development seemed a distinct possibility. However, the project was subsequently abandoned but Norseman appears to be thinking seriously about reviewing the project in one form or another.

Spain

Probably the most significant event in recent years affecting Spain's magnesite industry was the decision of *Magnesitas*

Navarras (Magna) to enter the caustic-calcined magnesite field. This affiliate of *Didier-Werke* of West Germany was appropriately enough set up in the first place to produce refractory magnesia from its operations in Zubirir in Navarra Province and it remains a well-regarded supplier of magnesia for open hearth and electric arc applications. Nevertheless the company was aware that its overall market was not an expanding one and thus the move to agricultural grade magnesia. Today the Zubiri plant has a capacity to produce 70,000 tpa of two dead-burned products (one brickmaking, one fettling) and 25,000 tpa of caustic magnesia. The company also has an arrangement with one of Spain's largest mineral processors, *Molinera Astur* of Gijon in Asturias. Astur is mining a grade of magnesite at Mallecina in Asturias suitable for calcination.

Meanwhile no news seems to be good news of *Magnesitas de Rubian*, Europe's number one producer of agricultural grade caustic magnesia. Despite increasing competition the company continues to experience strong demand for its product and production remains close to its 70,000 tpa capacity.

Turkey

Turkey's magnesite industry has received a fillip in recent years from the strong demand from the USSR for the dead-burned magnesite product from the *Kumas* operation at Kutahya in western Anatolia. A project to double capacity from the current 72,000 tpa level is currently believed to be at the commissioning stage. The country's two other dead-burning operations are the *Manyezit* operation at Eskisehir, now a joint venture between *Veitscher Magnesitwerke* of Austria and *Bazir Ates Tugla* of Istanbul, and the *Sumerbank* operation at Konya which produces magnesite almost exclusively for its own refractory production. The



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country's caustic magnesia specialist, *Comag*, has been particularly successful in recent years in building up its sales of higher purity magnesias, particularly fusing grade from its Kumbet operation, between Kutahya and Eskisehir.

Yugoslavia

The country's magnesite producer, *Magnohrom* of Kraljevo, has spent much time and effort over the past decade trying to locate deposits of high MgO magnesites similar to those of its southern neighbour, Greece, so that it could be come a significant producer and exporter of LD grade product. Indeed the company considered at one time building a 100,000 tpa seawater magnesia plant on the Adriatic coast to achieve such an end. However, these plans were abandoned and it would now appear that the company has settled for a more modest, but probably wiser, plan to build a 25,000 tpa plant to cover its own requirements (currently met by expensive imports). This plant is currently under construction and will be based on blends from its own natural magnesite with secondary sources.

Arab World developments

Projects involving both natural and synthetic magnesia remain on course in the Arab World. The Zarghat project in Saudi Arabia is still under development and in the Cah Chaouen region of Morocco a deposit is being evaluated with Bulgarian assistance. Magnesia also features highly in the plans of the *Arab Potash Co.* in Jordan, which started to extract potash and salt from the brines of the Dead Sea at Safi in 1982. Both magnesia and bromine are expected to be recovered when the second stage of the project takes place in the mid or late 1980s. Tunisia is also taking a serious look at the possibility of building a seawater magnesia plant in the Zarzis area.

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World magnesia producers

Company/Country	Location	Capacity*	Ownership/Other remarks
Europe and the Mediterranean area			
Austria			
Veitscher Magnesitwerke	Breitenau, Steiermark	300,000 DB N	Magnesia AG of Switzerland
Magindag (Steirische Magnesit)	Trieben, Steiermark	45,000 CC N	Veitscher Magnesitwerke General Refractories Group of the USA. Also produces around 30,000 tpa of by-product caustic flue dust OEAMAG/General Refractories
Oesterreichisch-Amerikanische Magnesit AG (OEAMAG)	Radenthein	120,000 DB N	
Tiroler Magnesit	Radenthein	50,000 CC N	
	Hochfilzen, Tirol	90,000 DB N	
Czechoslovakia			
Slovenska Magnesitove Zavody	Jelsava, Kosice, Lovinobana, and Lucenec	700,000 DB N	
East Germany			
VEB Kombinat Kali	Teutschendal Sonderhausen	30,000	By-product of potash mining and processing
Greece			
Fimisco - Financial Mining Industrial & Shipping	Mantoudi, Euboea	350,000 DB N 30,000 CC N	Scalistiri Group. Mines at Kakavos and Paraskevorama on Euboea Island are supplemented when necessary by output from Ormylia (Chalkidiki) and Lesvos Island Portolos Group
Macedonian Magnesite Co. Grecian Magnesite Co.	Yerakini, Chalkidiki	120,000 DB N 60,000 CC N	
	Kalyvia, Chalkidiki	25,000 CC N	OEAMAG/General Refractories Papastratis Group. Also produces special grades of raw magnesite
Magnumin General Mining	Vavdos, Chalkidiki	50,000 DB N	
Mining Trading & Manufacturing	Tamvakas, Euboea	15,000 CC N	
Irish Republic			
Premier Periclase	Drogheda, Co. Louth	100,000 DB+CC S	Cement Roadstone Holdings
Israel			
Dead Sea Periclase	Mishor Rotem, Arad	40,000 DB+CC B	Israel Chemicals/OEAMAG joint venture

Italy			
Sardamag	Sant' Antioco, Sardinia	120,000 DB+CC S	Uniref/SANAC/Didier-Werke joint venture
CoGeMa	Syracuse, Sicily	65,000 DB+CC S	Sardamag/Veitscher Magnesitwerke joint venture
Eraclit Venier	Portomarghera, Venice	25,000 CC	Eraclit Prefabbricati o Peseggia. Mine at Solda, BZ
Netherlands			
Magnesia International	Veendam, Groningen	100,000 DB+CC B	Shell/Billiton group
Norway			
Norsk Hydro	Porsgrunn, Oslofjord	25,000 CC S	Further 75,000 tpa output used for Mg metal production
Spain			
Magnesitas Navarras - Magna	Zubiri, Navarra	95,000 DB+CC N	Associate of Didier-Werke of West Germany
Magnesitas de Rubian	Monte Castelo, Lugo	70,000 CC N	Specialises in agricultural grades
Turkey			
Kumas - Kutahya Manyezit	Kutahya	72,000 DB N	Associate of Etibank. Expansion to 144,000 tpa in progress
Manyezit	Eskisehir	60,000 DB N	Bazik Ates Tugla/Veitscher Magnesitwerke joint venture
Comag - Continental Madencilik	Tavsanli, Eskisehir, and Bursa	40,000 CC N	Transturk Holdings
Sumerbank Konya Krom Magnezit	Konya	40,000 DB N	Sumerbank Genel Mudurlugu
United Kingdom			
Steetley Refractories Magnesia Materials Div.	Hartlepool, Cleveland	200,000 DB+CC S	Steetley PLC
USSR			
Satka Magnesite Combine	Satka, nr. Chelyabinsk	600,000 DB+CC N	
Sivash Magnesia Works	Sivash, Crimea	100,000 DB+CC S	
Yugoslavia			
Magnohrom	Kraljevo	250,000 DB+CC N	

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The Americas

United States of America

Martin Marietta Chemicals
Harbison-Walker Refractories

Manistee, Michigan
Ludington, Michigan

325,000 DB+CC B
200,000 DB B

Martin Marietta Corp.
Dresser Industries. H-W's seawater magnesia plant at
Cape May, New Jersey was closed permanently in July
1983
Combustion Engineering Group

CE-Basic

Gabbs, Nevada

100,000 DB N
130,000 CC N

Kaiser Refractories

Port St. Joe, Florida
Moss Landing,
California

27,000 I-B S
50,000 CC S
160,000 DB+CCS
150,000 CC S

Kaiser Aluminium & Chemical Corp.

Merck & Co.

San Francisco,
California

Sales through Calgon in Pittsburgh

Morton Chemical Co.
Woodville Lime
Barcroft
Western Magnesium

Midland, Michigan
Woodville, Ohio
Lewes, Delaware
Chula Vista,
California

10,000 CC B
5,000 CC D
5,000 CC S
5,000 CC S

Recently completed an expansion
Prepared from dolomite

FMC Corp.

Brazil

Magnesita SA
Ceramica de Guarulhos

Brumado, Bahia
Brumado, Bahia

315,000 DB N
18,000 CC N

South America's largest refractory manufacturer
Industrias Brasileiras de Artigos Refratarios (IBAR),
itself part of the Votorantim Group

Ibar Nordeste

Brumado, Bahia

25,000 DB N

Canada

Dresser Industries Canada

Kilmar, Quebec

60,000 DB N

Dresser Industries of the USA. Produces a 60% MgO
dead-burned dolomitic magnesite product
Refratechnik of West Germany

Baymag Mines

Mt. Brussiloff, Brit
Columbia

100,000 CC N

Magna

Thetford Mines,
Quebec

6,000 CC N

Ste Nationale d'Amiante. Prepared from asbestos waste

Mexico

Quimica del Rey

Laguna del Rey,
Coahuila

100,000 DB+CC B

Industrias Peñoles. Co-product sodium sulphate

Quimica del Mar

Ciudad Madero,
Tamaulipas

70,000 DB+CC S

Industrias Peñoles

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The Far East and Australia

Japan

Ube Chemical Industries	Ube, Yamaguchi	450,000 DB+CC S	Ube Industries. Capacity includes synthetic magnesio-dolomite production
Shin-Nihon Chemical Industries	Minamata, Kumamoto	100,000 DB+CC S	Asahi Chemical Industries. A third plant — at Toyama with 70/80,000 tpa capacity — was closed in mid-1982
Asahi Glass	Onahama, Fukushima Kitakyushu	25,000 DB+CC S 20,000 DB	Clinker plant within refractory works

India

Dalmia Magnesite Corp. Tamil Nadu Magnesite	Salem, Tamil Nadu Salem, Tamil Nadu	72,000 DB N 7,200 DB N 20,000 CC	Dalmia Cement Salem Magnesite/Tamil Nadu State Government joint venture
Burn Standard Almora Magnesite	Salem, Tamil Nadu Almora, Uttar Pradesh	20,000 DB N 30,000 DB N	Indian Government Uttar Pradesh/State Government/Belpahar Refractories/Steel Authority of India joint venture

China

Liaoning Magnesite Works	Dashhchiao, Liaoning	700,000 DB N 300,000 CC N	Sales through China National Minerals & Metals Import & Export Corp.
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North Korea

Korean Magnesite Works	Tanchon	600,000 DB N	Sales through Korea Paekgumsan Trading Corp.
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Australia

Harbison ACI	Fifield, NSW	15,000 DB N	Australian Consolidated Industries and Harbison-Walker of USA joint venture
Young Mining	Young, NSW	10,000 CC N	Devex Ltd.

Southern Africa

South Africa

Verref Mining	Burgersfort, Transvaal	35,000 DB N	Vereeniging Refractories
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Zimbabwe

Gatooma Magnesite	Gatooma	- N	Cullinan Refractories/Vereeniging Refractories of South Africa. Produces up to 7,000 tp month of raw magnesite for shipment to parent companies' plants in S. Africa
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*Capacity in metric tonnes per annum. DB — Dead-Burned; CC — Caustic Calcined; DB+CC — Predominantly Dead-Burned but with significant output of Caustic Calcined; N — Natural magnesite; S — Seawater Magnesia; B — magnesite from Brines

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