Magnesium Compounds

By E. Chin [1]

World production of magnesite in 1972, excluding production in the United States, was estimated to be 9,764,474 short tons, a decrease of 2% from world production in 1971. Magnesite production in Austria, Czechoslovakia, North Korea, People's Republic of China, and the U.S.S.R. accounted for 71% of the total world output. The increase in the world production capacity for recovering magnesia from sea water, however, continued to exert competitive pressure on producers of magnesite.

Refractory magnesia and caustic-calcined and specified magnesias sold or used by domestic producers in 1972 were 9% above that sold or used in 1971. The value of domestic shipments of magnesias rose 10% to $76,187,000.

U.S. imports for consumption of processed magnesite were 133,734 tons; imports from Greece accounted for 58% of the 1972 total. Exports of magnesite and magnesia were 61,196 tons in 1972, and as in the 1970–71 period were primarily to Canada.

Table 1.—Salient magnesium compounds statistics

(Thousand short tons and thousand dollars)

	1968	1969	1970	1971	1972
United States:					
Caustic-calcined and specified magnesias:[1]					
Shipments:					
Quantity	119	125	122	127	128
Value	$17,958	$19,876	$19,301	$18,621	$15,356
Exports:[2]					
Value	$2,301	$2,687	$3,200	$2,840	$3,377
Imports for consumption:[2]					
Value	$758	$983	$702	$736	$675
Refractory magnesia:					
Sold and used by producers:					
Quantity	661	737	802	627	696
Value	$44,535	$51,843	$60,333	$50,359	$60,331
Exports:					
Value	$4,706	$4,973	$9,133	$5,897	$5,903
Imports:					
Value	$6,179	$5,913	$7,357	$9,219	$9,300
Dead-burned dolomite:					
Sold and used by producers:					
Quantity	1,833	1,866	1,373	1,020	1,125
Value	$31,627	$33,580	$25,740	$19,128	$21,097
World: Crude magnesite production:					
Quantity	11,781	10,627	9,763	9,975	9,764

[1] Excludes caustic-calcined magnesia used in production of refractory magnesia.
[2] Caustic-calcined magnesia only.

DOMESTIC PRODUCTION

In 1972, 909,428 short tons of magnesium hydroxide was produced from sea water and well brines. Output was by Barcroft Co., The Dow Chemical Company, Kaiser Aluminum & Chemical Corp., Merck & Co., Inc., and Michigan Chemical Corp. Most of the magnesium hydroxide was used in the production of magnesia for basic refractories. Producers of refractory magnesia were Basic Inc., Basic Magnesia, Inc., Corchem, Inc., A. P. Green Refractories, Co., Harbison-Walker Refractories Co., Kaiser Aluminum & Chemical Corp., Martin-Marietta Chemicals (formerly Stand-

[1] Physical scientist, Division of Nonferrous Metals.

ard Lime and Refractories Co.), and Northwest Magnesite Co. Total production of refractory magnesia in 1972 was 575,707 tons.

During the year, 189, 889 tons of caustic-calcined magnesia was produced by Basic Inc., Basic Magnesia, Inc., The Dow Chemical Company, Kaiser Aluminum & Chemical Corp., Martin-Marietta Chemicals, and Michigan Chemical Corp. Six companies produced 11,091 tons of specified magnesias.

Magnesium chloride was produced by American Magnesium Co., J. T. Baker Chemical Co., The Dow Chemical Co., FMC Corp., Great Salt Lake Minerals & Chemicals Corp., Kaiser Aluminum & Chemical Corp., Mallinckrodt Chemical Works, and NL Industries, Inc. Most of the magnesium chloride production was used for magnesium metal cell feed.

Production of magnesium sulfate was reported by four companies. Producers of other magnesium compounds were J. T. Baker Chemical Co., Mallinckrodt Chemical Works, Merck & Co., Inc., and Waverly Chemical Co., Inc.

Basic Magnesia, Inc., completed an expansion program at its sea water magnesia plant in Port St. Joe, Fla., with the installation of special material processing equipment, increased bagging capacity, and new bulk loading facilities for both trucks and railroad cars. Improvements were also made in the reaction system controls, which were designed to yield more uniform and higher quality oxides.

Table 2.—Dead-burned dolomite sold or used by producers in the United States

(Thousand short tons and thousand dollars)

Year	Sales of domestic product	
	Quantity	Value
1968	1,833	31,627
1969	1,866	33,580
1970	1,373	25,740
1971	1,020	19,128
1972	1,125	21,097

Domestic producers of magnesium compounds by raw material source, location, and annual capacity are listed as follows:

Raw material source and producing company	Location	Capacity (short tons MgO equivalent)
Magnesite:		
Basic Inc	Gabbs, Nev	150,000
Lake brines:		
Great Salt Lake Minerals & Chemicals Corp	Ogden, Utah	100,000
NL Industries, Inc	Rowley, Utah	75,000
Well brines:		
American Magnesium Co	Snyder, Tex	50,000
The Dow Chemical Co	Ludington, Mich	250,000
Martin Marietta Chemicals	Manistee, Mich	100,000
Michigan Chemical Corp	St. Louis, Mich	25,000
Morton Chemical Co	Manistee, Mich	5,000
Sea water:		
Basic Magnesia, Inc	Port St. Joe, Fla	100,000
Barcroft Co	Lewes, Del	5,000
Corchem, Inc	Pascagoula, Miss	40,000
The Dow Chemical Co	Freeport, Tex	250,000
FMC Corp	Chula Vista, Calif	5,000
Kaiser Aluminum & Chemical Corp	Moss Landing, Calif	150,000
Merck & Co., Inc	South San Francisco, Calif	5,000
Northwest Magnesite Co	Cape May, N.J	100,000
Total		1,410,000

CONSUMPTION AND USES

In 1972, 696,102 tons of magnesia was used in the production of basic refractories, compared with 626,513 tons in 1971. Consumption of caustic-calcined magnesia for uses other than the production of refractory magnesia included chemical processing, animal feed, pulp and paper, rayon, and sugar. Specified magnesias were used primarily in electrical, medicinal, and rubber applications.

Olivine was consumed as a molding sand in various foundries and as a metallurgical flux in the smelting of steel.

Magnesium chloride was used as an antifreeze agent and in the processing of molasses. Magnesium carbonate was consumed in the production of cosmetics and pharmaceuticals.

Table 3.—Magnesium compounds shipped and used in the United States

Year and product	Plants	Shipped and used	
		Quantity (short tons)	Value (thousands)
1971			
Caustic-calcined [1] and specified (U.S.P. and technical) magnesias	12	r 126,722	r $18,621
Refractory magnesia [2]	9	r 626,513	r 50,359
Magnesium hydroxide (100 percent $Mg(OH)_2$) [1]	9	71,366	r 2,030
Magnesium chloride [3]	8	575,674	r 35,744
Precipitated magnesium carbonate [1]	6	5,510	r 1,251
1972			
Caustic-calcined [1] and specified (U.S.P. and technical) magnesias	11	128,260	$15,856
Refractory magnesia [2]	8	696,102	60,331
Magnesium hydroxide (100 percent $Mg(OH)_2$) [1]	10	66,671	2,454
Magnesium chloride [3]	9	559,709	36,202
Precipitated magnesium carbonate [1]	5	5,074	1,476

r Revised.
[1] Excludes material produced as an intermediate step in the manufacture of other magnesium compounds.
[2] Includes both single-burned and double-burned.
[3] Production for 1971, 827,486; 1972, 951,220; includes magnesium chloride used in the production of magnesium metal.

Table 4.—Domestic shipments of caustic-calcined and specified magnesias, by use

(Short tons)

Use	1971	1972
Agriculture, nutrition, and pharmaceuticals:		
Animal feed and fertilizer	18,406	23,498
Medicinals	6,319	W
Sugar, candy, and winemaking	3,186	4,532
Total	27,911	28,030
Construction materials:		
Insulation and wallboard	W	W
Oxychloride and oxysulfate cement	13,248	17,315
Total	13,248	17,315
Chemical processing, manufacturing, and metallurgical:		
Chemicals	25,873	33,831
Electrical heating rods	704	2,364
Flux	W	W
Petroleum additive	W	W
Pulp and paper	14,612	15,312
Rayon	15,167	W
Rubber	3,704	7,411
Uranium processing	W	W
Water treatment	1,428	W
Total	62,508	72,712
Unspecified uses	23,055	10,203
Grand total	126,722	128,260

W Withheld to avoid disclosing individual company confidential data; included with "Total."

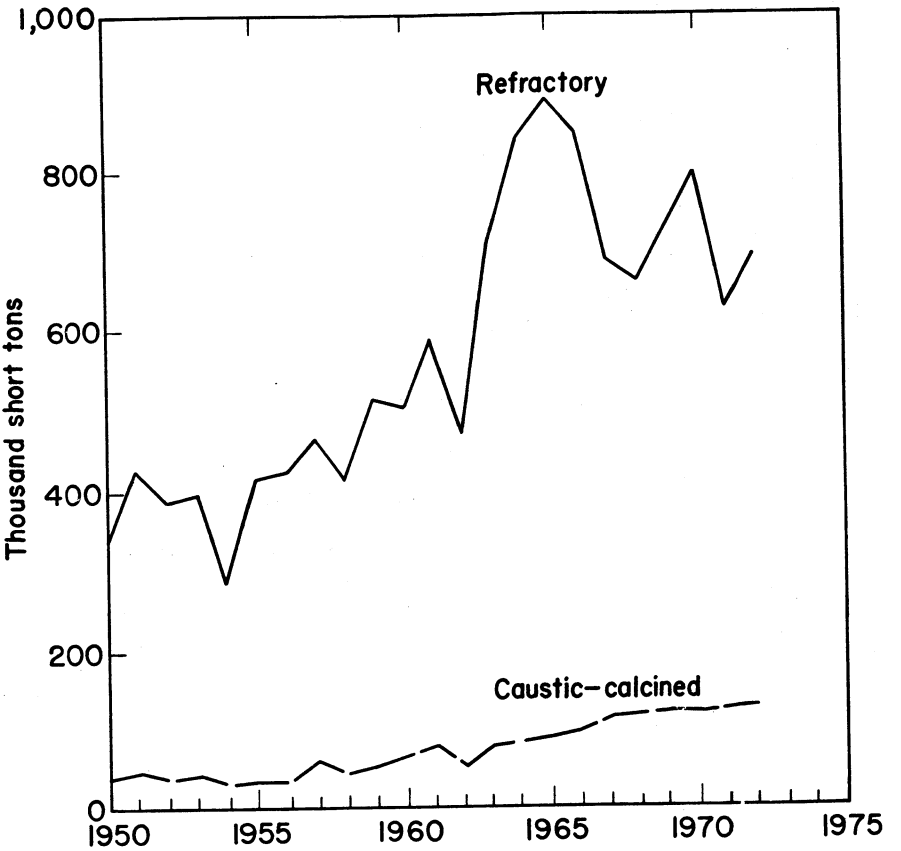

Figure 1.—Consumption and shipments of magnesia in the United States.

PRICES

Prices for magnesia, calcined, technical, heavy, 85% and 90% (bags, carlot, f.o.b. Luning, Nev.) were quoted during the year at $50 and $60 per short ton, respectively according to the Chemical Marketing Reporter. Magnesia, technical, synthetic rubber-grade, neoprene-grade, light, was quoted with no change from the 1971 price at $0.24 per pound (bags, carlot, freight-equalized).

Prices throughout the year for magnesium carbonate, technical (bags, carlot, freight-equalized), remained the same as in 1971 at $0.16 per pound; for truckload quantities prices remained at $0.18 to $0.185 per pound. During the year the price for magnesium hydroxide, NF, powder (drums, carlot, and truckload, works) ranged from $0.21 to $0.295 per pound. Magnesium chloride, hydrous, 99%, flakes, bags, carlot, works, was quoted at $72.80 per ton. The price for magnesium lauryl sulfate, tanks, freight-allowed, remained the same as in 1971 at $0.175 per pound.

FOREIGN TRADE

Exports of dead-burned magnesite and magnesia in 1972 totaled 54,159 tons compared with 53,448 tons in 1971. Exports to Canada in 1972 were 51,694 tons, 21%

higher than in 1971. However, shipments to Mexico, Peru, and Spain in 1972 were substantially lower than those of 1971.

Exports of magnesite, including crude, caustic-calcined, lump or ground, decreased slightly from exports in 1971. Deliveries to West Germany, Canada, Italy, the United Kingdom, and Australia accounted for over 50% of the exports in this class.

Imports for consumption of lump or ground caustic-calcined magnesia decreased 10% in 1972 to 10,376 tons. Imports in this class were principally from India and Turkey.

Imports of dead-burned and grain magnesia and periclase containing a maximum of 4% lime increased 10% to 127,776 tons in 1972. Imports for the same class of material but containing over 4% lime decreased from 13,146 tons in 1971 to 5,958 tons in 1972. Total imports of magnesite increased 4% over those in 1971 to 133,734 tons.

Imports of unspecified magnesium chloride, magnesium sulfate, and magnesium salts and compounds decreased substantially in 1972 compared to imports in these classes in 1971. Imports of precipitated magnesium carbonate and magnesium oxide increased slightly over those in 1971.

The tariff on various magnesium compounds was as follows:

Item	1971	1972
Magnesite:		
Crude, per ton	$3.15	$2.62
Caustic-calcined, do	$6.30	$5.25
Magnesium carbonate:		
Precipitated, cents per pound	0.25	0.25
Not precipitated-% valorem	5%	4%
Magnesium chloride:		
Anhydrous, cents per pound	.6	.5
Other, do	.25	.21
Magnesium oxide:		
Calcined magnesia, do	1.2	1
Magnesium sulfate:		
Epsom salts, do	.225	.187

Table 5.—U.S. exports of magnesite and magnesia, by country

Destination	Magnesite and magnesia, dead-burned				Magnesite, n.e.c., including crude caustic-calcined, lump or ground			
	1971		1972		1971		1972	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Argentina	330	$49	774	$115	80	$34	113	$51
Australia	120	68	20	9	450	254	442	237
Belgium-Luxembourg	--	--	--	--	107	44	87	36
Brazil	28	7	11	6	52	24	122	57
Canada	40,586	4,040	51,694	5,064	893	360	1,105	486
Chile	975	97	329	22	121	32	75	23
Colombia	--	--	--	--	12	6	19	10
Costa Rica	--	--	--	--	262	27	1	(1)
Denmark	--	--	--	--	34	19	28	17
El Salvador	5	1	5	1	550	55	--	--
Finland	--	--	6	4	89	35	181	100
France	62	9	50	5	274	103	342	209
Germany, West	157	81	180	98	890	445	1,269	598
Honduras	56	8	--	--	--	--	25	4
Israel	--	--	--	--	27	14	29	15
Italy	--	--	18	15	592	258	701	332
Japan	44	27	55	39	47	13	26	14
Mexico	5,679	569	7	4	102	19	78	22
Netherlands	50	7	48	17	264	87	182	72
New Zealand	36	23	32	21	116	67	125	81
Peru	1,667	154	--	--	5	2	12	6
Philippines	3	1	27	7	105	33	5	3
South Africa, Republic of	81	52	104	75	314	174	200	94
Spain	2,432	224	1	(1)	281	82	151	63
Sweden	76	42	72	50	310	212	362	262
Switzerland	--	--	16	3	62	22	51	20
Taiwan	--	--	--	--	--	--	168	52
U.S.S.R.	--	--	--	--	--	--	54	42
United Kingdom	718	397	566	321	755	318	634	297
Venezuela	305	32	50	7	66	14	154	20
Yugoslavia	--	--	--	--	11	7	80	53
Other	38	9	94	20	179	80	216	101
Total	53,448	5,897	54,159	5,903	7,050	2,840	7,037	3,377

[1] Less than ½ unit.

Table 6.—U.S. imports for consumption of crude [1] and processed magnesite, by country

Country	1971		1972	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Lump or ground caustic-calcined magnesia:				
Australia	498	$52	231	$27
Austria	561	24	520	19
Belgium-Luxembourg	6	1	--	--
Greece	426	34	917	82
India	7,848	458	6,711	378
Netherlands	177	15	222	20
New Zealand	162	17	--	--
Turkey	1,840	135	1,775	149
Total	11,518	736	10,376	675
Dead-burned and grain magnesia and periclase:				
Not containing lime or not over 4% lime:				
Australia	60	5	964	96
Austria	6,761	448	8,323	526
Canada	149	9	112	12
Germany, West	--	--	6	3
Greece	76,267	6,392	76,921	5,360
Ireland	26,616	1,967	24,827	2,004
Italy	--	--	3	(2)
Japan	6,009	362	5,434	364
Mexico	--	--	3	(2)
Poland	--	--	5,616	468
United Kingdom	17	36	5,556	466
Yugoslavia	--	--	11	1
Total	115,879	9,219	127,776	9,300
Containing over 4% lime:				
Austria	2,408	138	2,717	163
Canada	2,417	165	3,208	230
Spain	2,927	151	--	--
Yugoslavia	5,394	341	33	2
Total	13,146	795	5,958	395
Grand total	129,025	10,014	133,734	9,695

[1] Crude magnesite 1971, 7 S.T. ($303); 1972, none.
[2] Less than ½ unit.

Table 7.—U.S. imports for consumption of magnesium compounds

Year	Oxide or calcined magnesia		Magnesium carbonate (precipitated)		Magnesium chloride (anhydrous)		Magnesium chloride (other)		Magnesium sulfate (epsom salts and kieserite)		Magnesium salts and compounds n.s.p.f.[1]	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1970	521	$200	808	$192	--	--	824	$26	34,939	$617	3,608	$327
1971	628	222	138	60	26	$2	435	15	45,597	654	2,889	304
1972	690	256	139	73	22	1	250	8	21,538	378	2,662	395

[1] Not specifically provided for; includes magnesium silicofluoride or fluosilicate and calcined magnesia.

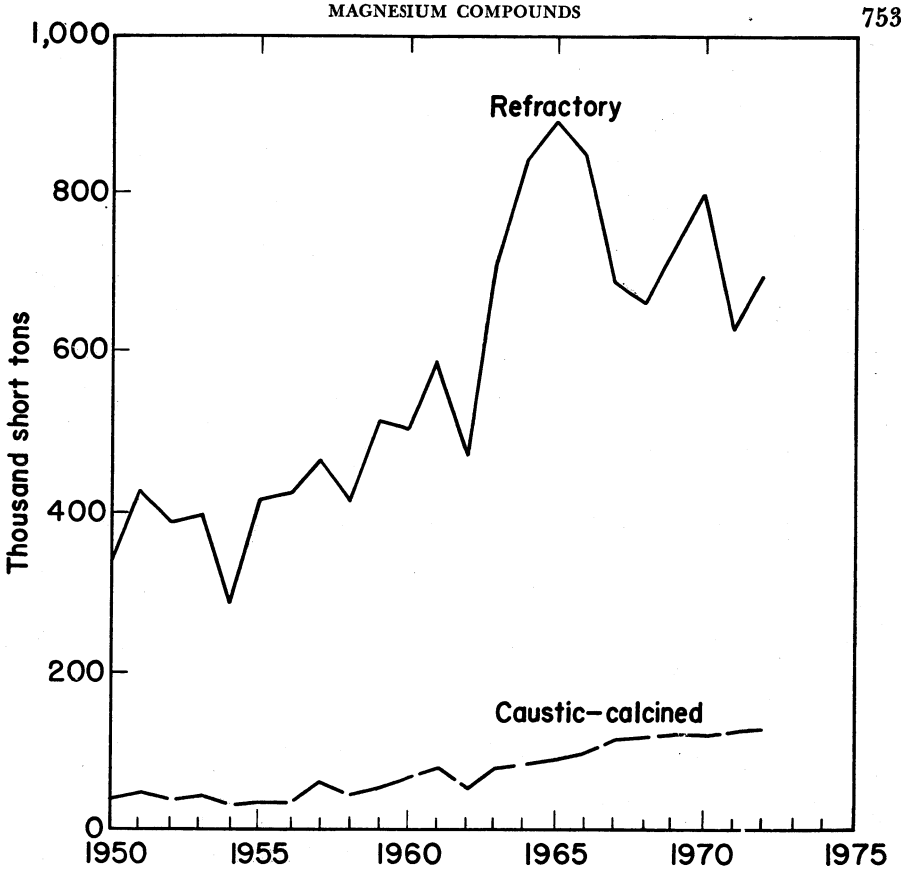

Figure 2.—Value of U.S. exports and imports of magnesia.

WORLD REVIEW

Germany, West.—Magnesital-Feuerfest G.m.b.H. initiated construction of its $10 million refractory plant at Oberhausen in the Duisburg area of the Ruhr District. Magnesital-Feuerfest is a joint venture of Dresser Industries, Inc., and Martin & Pagenstecher G.m.b.H., a West German refractories producer. The plant is being built in two phases. The first phase, which calls for the manufacture of high-alumina specialty refractories, is expected to be completed in early 1973. The second phase, for the manufacture of high-quality magnesia refractories used primarily in basic oxygen steelmaking processes, is scheduled to be completed and in operation by December 1973.

Greece.—Société Financière de Grèce (Scalistiri), the largest producer of magnesite in Greece, completed construction of a new loading jetty at Mantoudi, Northern Euboea. With the new jetty, magnesite can be loaded at a rate of 1,000 tons per hour. Other additions such as new silos and a belt conveyor were planned by mid-1973.

India.—Almora Magnesite Ltd. was installing a magnesite processing plant near Almora, Uttar Pradesh. Expected completion date for the construction was the fall of 1973. The plant was expected to produce 100,000 tons of dead-burned magnesite per year. Almora was owned 51% by the UP State Industrial Corp. and 49% by Belpahar Refractories Ltd.

Italy.—Compagnia Generale de Magnesio S.p.A. continued the construction of its 60,000 ton per year sea water magnesia plant near Syracuse, Sicily. Construction of the plant began in August 1971, and at the end of 1972 was nearing completion. Initial production of chemical and refractory magnesia was scheduled for late 1973. High-purity limestone deposits are available at the site and will probably permit

an increase of the magnesium oxide content of the magnesia produced at the plant to over 98%.

Netherlands.—Shell Internationale Petroleum Maatschaapij installed a high-pressure water heater at its magnesium salt recovery pilot plant on the Friesian coast. Although fitted with an air atomizing burner for use with oil, the dual fuel heater was fired on natural gas and can handle a water flow of 66,000 pounds per hour.

Tanzania.—The National Development Corp. (NDC) of the Tanzanian Government planned to invest between $280,000 and $344,000 to revive and expand magnesite mining near Samé. This mine was formerly operated by the Tanganyika Magnesite Mines, Ltd. The NDC expected to establish a 24,000-ton-per-year magnesite plant by 1974 and to continue operations for 15 to 20 years on the basis of reserves which have been estimated to be between 1 million and 4 million tons.

United Kingdom.—Steetley Co., Ltd., commissioned a new plant at its Hartlepool works for the production of chemical-grade magnesia. The new plant included a gas-fired, multiple-hearth furnace equipped with special burners designed by Steetley's Central Research Laboratories. The design and instrumentation of the furnace reportedly allowed close control of burning conditions, which permitted a high degree of flexibility in achieving precise physical and chemical specifications, tailored to meet customer requirements.

Yugoslavia.—The state-owned refractory materials producing complex, Magnohrom, announced a $30 million expansion and modernization program of its mining and manufacturing plants at Kraljevo. The expansion program, to be completed by 1975, was expected to increase the present production of 100,000 tons of magnesite brick to 160,000 tons per year, and to increase the production of refractory materials for the steel industry from 4,000 tons to 40,000 tons per year. Plans for the country's first magnesium metal producing facilities were included in the project.

Table 8.—Magnesite: World production by country [1]

(Short tons)

Country	1970	1971	1972 [p]
North America: United States	W	W	W
South America:			
Brazil [e]	260,000	296,000	[e] 300,000
Mexico	[r] 7,635	14,350	[e] 15,000
Europe:			
Austria	1,773,992	1,715,700	1,575,660
Czechoslovakia	[r] 695,768	[r] 682,288	[e] 680,000
Greece	832,438	995,064	[e] 990,000
Poland [e]	55,000	55,000	55,000
Spain	[r] 245,203	[e] 250,000	[e] 250,000
U.S.S.R. [e]	1,569,000	[r] 1,600,000	1,650,000
Yugoslavia	[r] 564,221	543,126	465,000
Africa:			
Kenya	4	244	[e] 250
Rhodesia, Southern [e]	20,000	22,000	22,000
South Africa, Republic of	92,874	86,711	75,830
Sudan	110	[e] 110	[e] 110
Tanzania	[r] 761	1,103	[e] 1,100
Asia:			
China, People's Republic of [e]	1,100,000	1,100,000	1,100,000
India	384,664	329,800	301,000
Iran [2]	22,000	23,000	[e] 23,000
Korea, North [e]	1,800,000	1,900,000	1,900,000
Pakistan	[r] 513	239	324
Turkey	313,946	339,306	[e] 340,000
Oceania:			
Australia	24,759	19,943	[e] 19,000
New Zealand	534	1,154	[e] 1,200
Total	9,763,422	9,975,138	9,764,474

[e] Estimate. [p] Preliminary. [r] Revised.
W Withheld to avoid disclosing individual company confidential data.
[1] Figures presented are crude salable magnesite. In addition to the countries listed, Bulgaria, Canada, and Colombia produce magnesite, but output is not reported, and available information is inadequate to make reliable estimates of output levels.
[2] Year beginning March 21 of that stated.

World sea water magnesia production facilities by company and annual capacity are as follows:

Country	Location	Company	Capacity (short tons MgO)
Canada	Aguathuna, Newfoundland	Lundrigan's Ltd	30,000
Ireland	Dungarvan, Waterford	Pfizer Chemical Corp	75,000
Israel	Arad	Dead Sea Works, Ltd	50,000
Italy	Syracuse, Sicily	Compagnia Generale de Magnesio S.p.A.[1]	60,000
	Sant'Antioco, Sardinia	Sardamag S.p.A	120,000
	Hotsu	Hokuriku Seien K.K	35,000
Japan	Navetsu	Nihon Kasui Kako	120,000
	Minamata, Onohama, Toyama	Shin-Nihon Chemical Industries Co.	170,000
	Ube, Yamaguchi	Ube Chemical Industries Co., Ltd	420,000
Mexico	Ciudad Madero, Tampico	Quimica del Mar SA	50,000
Norway	Heroya, Oslo Fjord	Norsk Hydro-Elektrisk Kvaelstof A/S.	80,000
U.S.S.R.	NA		100,000
United Kingdom	Hartlepool County, Durham	Steetley, Ltd	250,000
United States	(2)		660,000
Total			2,220,000

NA Not available.
[1] Under construction.
[2] Sea water production facilities appear in tabulation shown in "Domestic Production" section of this chapter.

TECHNOLOGY

The Philadelphia Electric Company is installing a prototype system to absorb sulfur dioxide from flue gas with magnesium oxide.[2] The system will be in operation in late 1973 and will be the first of its kind installed on a coal-fired unit. The total cost of the facilities will be approximately $15 million.

The Potomac Electric Power Company planned to install a prototype system also to absorb sulfur dioxide from flue gas with magnesium oxide using a process developed by Chemical Construction Company and Basic Chemicals of Cleveland.[3] This plant will not probably be in operation before 1975. The approximate cost of the facilities will be about $6 million.

New methods to beneficiate domestic olivine for foundry sand applications were investigated.[4] A disadvantage of calcining olivine in conventional rotary kiln or fluid-type calciners is partial oxidation of ferrous oxide, which is undesirable in foundry sands. A laboratory tube-type furnace, making use of the free-flowing properties of olivine sand, was designed for continuous calcining. Utilizing this technique, high-quality foundry sand could be produced from olivine by calcining under nonoxidizing conditions.

A report on the refractory magnesia industry in Canada was published by the Mines Branch of the Department of Energy, Mines, and Resources.[5] The review included information on the occurrence of magnesite, current commercial exploitation of magnesite, and sea water magnesia in Canada. An article was published summarizing the development work leading to the analysis of periclase products by atomic absorption.[6] Test results showed that agreement between atomic absorption and wet chemical methods for calcium oxide, silica, iron and alumina were good. It was concluded that atomic absorption methods were suitable for quality control analyses of periclase grain containing greater than 95% MgO.

[2] Assessment of the State-of-Technology of Air Pollution Control Equipment and of the Impact of Clean Air Regulations on the Adequacy of Electric Power Supply of North America Bulk Power Systems. National Electric Reliability Council, Appendix G, October 1972.
[3] Gas Scrubber for Pepco. The Washington Daily News. No. 51, Jan. 5, 1972, p. 22.
[4] Bedeker, Immo H. Beneficiation of Olivine for Foundry Sand by Calcining. Minerals Research Laboratory, Report No. MRL-2, North Carolina State Univ., August 1972. 17 pp.
[5] Palfreyman, M. Refractory-Grade Magnesia in Canada. Tech. Bull., TB 163, November 1972.
[6] Werner, Glen E. Analysis of Periclase by Atomic Absorption (AA). Prize Winning Papers in the 1972 Award Contest for the Best Papers on any Phase of Refractories. April 13–14, 1972, pp. 21–30; available from The Refractories Institute, 3154 One Oliver Plaza, Pittsburgh, Pa. 15222.