



2007 Minerals Yearbook

MAGNESIUM COMPOUNDS [ADVANCE RELEASE]

MAGNESIUM COMPOUNDS

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Domestic production of caustic-calcined magnesia and dead-burned (refractory) magnesia in 2007 declined from that in 2006, and imports continued to account for most of the U.S. consumption of magnesia. Consumption of refractory magnesia was about 6% less than that in 2006. Caustic-calcined (and other) magnesia consumption decreased by 11%, with imports accounting for about 52% of total U.S. consumption.

About 41% of U.S. magnesium compounds production came from seawater and well and lake brines. The remainder was recovered from brucite, dolomite, magnesite, and olivine. About 60% of the total consumption of magnesium compounds was for refractory applications. The remaining 40% was used in agricultural, chemical, environmental, and other applications. China remained the dominant supplier of imports for caustic-calcined and refractory (dead-burned and fused) magnesias, with 87% and 83%, respectively, of the totals.

Production

U.S. shipments of caustic-calcined magnesia declined by 6% from those in 2006, and refractory magnesia shipments decreased as well (table 3). Magnesium hydroxide shipments remained at the same level as those in 2006.

Data for magnesium compounds were collected by the U.S. Geological Survey from one voluntary survey of U.S. operations. Of the 16 operations canvassed, 94% responded, representing 99% of the magnesium compounds shipped and used, including data for some compounds that were not reportable in table 3. Data for the single nonrespondent were estimated on the basis of prior-year production levels.

The largest capacity magnesite processing facilities in the world are in China, North Korea, and Russia. Together, these three countries accounted for two-thirds of the world magnesite production capacity. Japan and the United States accounted for about one-half of the world's magnesium compounds production capacity from seawater or brines. Fused magnesia was produced in Australia, Brazil, China, Israel, Japan, the Republic of Korea, Mexico, Russia, the United Kingdom, and the United States. World production capacity was estimated to be about 560,000 metric tons per year (t/yr), including about 372,000 t/yr of capacity in China (Schroeder, 2006). Fused magnesia was produced by one company in the United States—UCM Group PLC of the United Kingdom, which operated a plant in Cherokee, AL, through its Muscle Shoals Minerals Inc. subsidiary.

Norway is the world's principal producer and supplier of olivine. Other producers include Australia, Austria, Brazil, China, Denmark (Greenland), Greece, Italy, Japan, the Republic of Korea, Mexico, Spain, Taiwan, Turkey, and the United States. Rudi (2001) estimated that total world production of

olivine averaged about 4 million metric tons per year (Mt/yr), with about 3.3 Mt/yr consumed in Europe. An additional 4 Mt/yr of dunite and serpentinite, which are often commercially called olivine, is produced. Two companies in the United States produced olivine—Olivine Corp. and Unimin Corp. Olivine operated one mine and one processing plant in Washington. Unimin operated a mine in North Carolina and processing plants in Indiana and North Carolina.

Compass Minerals International Inc. (through its Great Salt Lake Minerals subsidiary) planned to spend \$25 million to upgrade its processing plant and modify its solar evaporation ponds near the Great Salt Lake in Utah. The 3-year expansion, which was scheduled to begin in 2008, was expected to increase the company's sulfate of potash production by 20%, and the company's magnesium chloride brine production likely would increase as well. The State of Utah agreed to lease 23,000 additional acres to the firm to build new solar evaporation ponds. The company was required to get construction permits from the U.S. Army Corps of Engineers to build these additional ponds (Green Markets, 2007).

Consumption

In 2007, environmental applications (water treatment and stack-gas scrubbing, in descending order) were the largest tonnage end use for caustic-calcined magnesia, with 58% of the total. The following categories, with the individual components in descending order of consumption in parentheses, were the other end-use sectors for caustic-calcined magnesia: agriculture (animal feed and fertilizers), 19%; chemical, 18%; construction (primarily oxychloride and oxysulfate cements), 3%; manufacturing (fluxes, rubber, and electrical), 2%; pharmaceuticals and nutrition and unspecified uses, each less than 1%.

Magnesium hydroxide was used mainly for water treatment, as a chemical intermediate, and in medicines and pharmaceuticals (uses are given in descending order of quantity). Smaller applications for magnesium hydroxide were in fertilizer, in rubber processing, and in the construction industry. Magnesium sulfate was used mostly for chemical, pulp and paper, fertilizer, rubber, pharmaceutical, water treatment, cosmetics, and construction applications (in descending order of quantity). Magnesium chloride was used mainly for ice control. Magnesium chloride brines were used for road dust and ice control.

Prices

Price data for magnesium compounds were not published in 2007. Because of the wide range of grades and applications of

caustic-calcined and dead-burned magnesias, average values derived from U.S. production or export data would not be representative of a price for any specific product.

Foreign Trade

In 2007, dead-burned magnesia exports were 12% higher than those in 2006 (table 5). Canada (79%) was the principal destination. Caustic-calcined magnesia exports were 22% lower than those in 2006. The Netherlands (35%) and France (32%) were the main destinations (table 4).

Imports of caustic-calcined magnesia were 18% lower than those in 2006, and imports of dead-burned magnesia were slightly higher than those in 2006. For both types of magnesia, China was the principal source country (table 6).

Trade data for olivine are not available separately from the U.S. Census Bureau. The Journal of Commerce Port Import/Export Reporting Service (PIERS), however, provides data on material that travels by ship. U.S. exports of olivine were 17 metric tons (t) in 2007, almost all of which was exported to Taiwan. U.S. olivine imports were 95,200 t, 44% less than those in 2006. Norway, with 99% of the total, was the principal source of olivine imports to the United States.

World Review

Brazil.—A private equity group, GP Investments Ltd., purchased Magnesita S.A., the leading magnesite producer in Brazil. The company's magnesia plant had the capacity to produce 345,000 t/yr of dead-burned magnesia and 70,000 t/yr of caustic-calcined magnesia. Most of the dead-burned magnesia was consumed internally to produce magnesia-base refractories, about 70% of which was used by Brazil's steel industry. From 2003 through 2006, Magnesita had invested \$100 million to increase production, improve quality, and introduce new refractory products for the steel industry. The equity firm planned to expand the business further, although no specific details were available (O'Driscoll, 2007a).

Canada.—Baymag Inc. stopped producing fused magnesia in 2006. The company's parent firm (German-based Refratechnik GmbH) had invested in fused magnesia plants in China, so production from Baymag's Alberta plant was no longer needed (Simandl, 2007).

China.—Industry sources reported that significant quantities of dead-burned magnesia have been smuggled out of China to the Republic of Korea without payment of export license fees and duties; the material then was exported to Europe and the United States. This material reportedly was being offered at prices that were \$25 to \$40 per metric ton lower than comparable export prices from China. In addition, China instituted a 5% export tax on magnesia on July 1, further exacerbating the smuggling problem (O'Driscoll, 2007b).

Jordan.—Jordan Magnesia Co. Ltd. (Jormag) (a subsidiary of Arab Potash Co.) was engaged in International Chamber of Commerce arbitration proceedings with its construction contractor AMEC Americas Ltd. concerning the construction of its recently built magnesia plant. After the company and the contractor reached a settlement agreement, Jormag received

\$41.0 million in May. The company planned to use \$5 million of the settlement to pay Social Security and other third-party liabilities and retain the balance (Arab Potash Co., 2007). Although the plant had been completed in 2003, it ran for only about 1 year because of technical problems. The plant has been idle since yearend 2004.

Russia.—Nikochem LLC, which began producing magnesium chloride from bischofite in Volgograd, Russia, at the end of 2006, announced that it would construct a plant to produce high-purity magnesium oxide and magnesium hydroxide. The new production, which was scheduled to start in 2009, would come from thermal decomposition of bischofite. When completed, the new plant would be capable of producing 15,000 t/yr of magnesium oxide and 20,000 t/yr of magnesium hydroxide (Industrial Minerals, 2007a).

Serbia.—In March, the Kosovo Trust Agency received final bids for the area's two magnesite mines, XIM Strezoc Magnesite Mine and Goleshi Magnesite Mine. Although the bidders were identified only by number, the successful bidder for the XIM Strezoc Mine was reported to be the Croatian company Iming d.o.o., with a bid of €730,000 and a guaranteed investment of €14,300,000. The purchaser of the Goleshi Magnesite Mine was not identified, but had a winning bid of €810,000 and a guaranteed investment of €16,200,000 (Kosovo Trust Agency, 2007). Although both operations had produced dead-burned and caustic-calcined magnesia prior to the Balkan conflict in the early 1990s, neither had produced since the early 2000s.

Turkey.—ŞETAT Madencilik Gıda Sanayi ve Ticaret A.Ş. (Setat Mining) began producing magnesite in 2007. The company began producing at a 60,000-t/yr rate from deposits in the Bursa and Orhaneli regions. Setat Mining had begun producing olivine in 2005 from the Orhaneli deposit and has traditionally produced chromite from the same region (Industrial Minerals, 2007b).

Outlook

According to the International Iron and Steel Institute (2008), world crude steel output reached 1.34 billion metric tons in 2007, an increase of 7.5% from that in 2006. This total represents the highest level of crude steel output in history, and it is the fifth consecutive year that world crude steel production grew by more than 7%. China's steel production in 2007 reached 489 Mt, a 15.7% increase from that in 2006. Although a 15.7% growth rate is significant, it was lower than growth rates from 2004 to 2006. Excluding China, world crude steel production from 2006 to 2007 increased by only 3.3%. China represented more than 36% of total world production in 2007. A sustained increase in steel production in China could lead to more internal consumption of magnesia-based refractories, which could result in less magnesia available for the export market. China, however, has significant magnesite resources, particularly in Liaoning Province, and most likely would continue to develop the magnesite deposits to satisfy domestic and export markets.

Most caustic-calcined magnesia markets are fairly mature, but use of caustic-calcined magnesia and magnesium hydroxide for environmental applications was expected to continue to grow. Because of its superior properties, magnesium hydroxide

was expected to continue to replace such materials as lime and caustic soda in some environmental applications. In addition, the use of magnesium hydroxide as a flame retardant material in specialized wire and cable applications could present an area for growth.

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TABLE 1
SALIENT MAGNESIUM COMPOUND STATISTICS¹

(Thousand metric tons and thousand dollars)

	2003	2004	2005	2006	2007
United States:					
Caustic-calcined and specified magnesias: ²					
Shipped by producers: ³					
Quantity	154	132	137	133 ^r	125
Value	61,000	55,400	60,300	60,300 ^r	41,100
Exports ⁴	4	4	5	6	4
Imports for consumption ⁴	150	157	152	163	134
Refractory magnesia:					
Shipped by producers: ³					
Quantity	84	W	W	W	W
Value	23,500	W	W	W	W
Exports	56	30	25	20	22
Imports for consumption	379	418	478	433	437
World, production of magnesite	14,100 ^r	16,500 ^r	15,100 ^r	15,000 ^r	15,200 ^c

^cEstimated. ^rRevised. W Withheld to avoid disclosing company proprietary data.

¹Data are rounded to no more than three significant digits.

²Excludes caustic-calcined magnesia used in the production of refractory magnesia.

³Includes magnesia used by producers.

⁴Caustic-calcined magnesia only.

TABLE 2
U.S. MAGNESIUM COMPOUND PRODUCERS, BY RAW MATERIAL SOURCE, LOCATION, AND PRODUCTION CAPACITY, IN 2007¹

(Metric tons, MgO equivalent)

Raw material source and producing company	Location	Capacity	Products
Brucite, Applied Chemical Magnesias Corp.	Van Horn, TX, and Bullhead City, AZ	25,000	Magnesium hydroxide.
Magnesite, Premier Chemicals LLC	Gabbs, NV	140,000	Caustic-calcined magnesia.
Lake brines:			
Great Salt Lake Minerals Corp.	Ogden, UT	185,000	Magnesium chloride and magnesium chloride brines.
Intrepid Wendover-Potash LLC	Wendover, UT	45,000	Magnesium chloride brines.
Well brines:			
Martin Marietta Magnesia Specialties LLC ²	Manistee, MI	314,000	Caustic-calcined magnesia, dead-burned magnesia, and magnesium hydroxide.
Rohm and Haas Co.	do.	25,000	Caustic-calcined magnesia and magnesium hydroxide.
Seawater:			
Premier Chemicals LLC	Port St. Joe, FL	107,000	Do.
South Bay Salt Works	Chula Vista, CA	3,000	Magnesium chloride brines.
SPI Pharma Inc.	Lewes, DE	5,000	Magnesium hydroxide.
Total		849,000	

do. Ditto.

¹Data are rounded to no more than three significant digits; may not add to total shown.

²In addition to its Michigan plant, Martin Marietta owned a 15,000-metric-ton-per-year-capacity magnesium hydroxide plant in Lenoir City, TN, which used imported magnesite as a raw material.

TABLE 3
U.S. MAGNESIUM COMPOUNDS SHIPPED AND USED¹

	2006		2007	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Caustic-calcined and specified (USP and technical) magnesias ²	133,000 ^r	\$60,300 ^r	125,000	\$41,100
Magnesium hydroxide [100% Mg(OH) ₂] ²	173,000 ^r	84,600 ^r	173,000	81,000
Magnesium sulfate, anhydrous and hydrous	45,500 ^r	12,800 ^r	48,900	13,400
Refractory magnesia	W	W	W	W

^rRevised. W Withheld to avoid disclosing company proprietary data.

¹Data are rounded to no more than three significant digits.

²Excludes material produced as an intermediate step in the manufacture of other magnesium compounds.

TABLE 4
U.S. EXPORTS OF CRUDE AND PROCESSED MAGNESITE, BY COUNTRY¹

Material and country	2006		2007	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Caustic-calcined magnesia:				
France	1,810	\$1,080	1,430	\$871
Germany	569	345	721	449
Netherlands	1,500	915	1,560	985
Venezuela	1,480	615	150	68
Other	319	253	563	406
Total	5,690	3,210	4,420	2,780
Dead-burned and fused magnesia:				
Brazil	219	190	54	41
Canada	16,200	7,630	17,700	7,990
France	61	50	238	214
Germany	721	550	605	492
Mexico	549	832	1,660	1,120
Netherlands	52	46	371	810
Poland	319	236	119	104
Taiwan	242	162	258	173
United Kingdom	252	238	240	227
Venezuela	52	34	261	132
Other	1,360 ^r	1,390 ^r	866	748
Total	20,000	11,400	22,400	12,000
Other magnesia:				
Brazil	805	1,020	1,490	1,590
Canada	5,820	3,350	3,210	2,630
France	473	338	402	406
Germany	2,280	1,680	345	269
Hong Kong	865	916	733	745
Korea, Republic of	534	806	1,070	1,230
Mexico	2,010	2,130	1,980	2,220
Taiwan	856	677	1,100	974
Turkey	672	733	867	938
United Kingdom	888	1,170	259	394
Venezuela	1,110	766	461	479
Other	4,880 ^r	5,290 ^r	3,630	4,620
Total	21,200	18,900	15,500	16,500
Crude magnesite:				
Argentina	442	47	1,130	129
Canada	2,780	369	2,770	382
China	--	--	1,390	268
France	983	105	2,460	281
Germany	1,740	186	591	72
Mexico	385	45	761	126
Sweden	1,040	139	--	--
Other	1,650 ^r	185 ^r	2,570	294
Total	9,020	1,080	11,700	1,550

^rRevised. -- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 5
U.S. EXPORTS OF MAGNESIUM COMPOUNDS¹

Material	2006		2007		Principal destinations, 2007
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	
Magnesium chloride, anhydrous and other	7,650	\$5,470	7,690	\$5,480	Canada, 86%.
Magnesium hydroxide and peroxide	14,200	12,000	15,200	11,800	Canada, 55%; United Kingdom, 13%; Mexico, 11%.
Magnesium sulfate, natural kieserite and epsom salts	303	208	733	474	Canada, 86%.
Magnesium sulfate, other	9,600	4,260	10,500	5,100	Canada, 85%; Saudi Arabia, 10%.

¹Data are rounded to no more than three significant digits.

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF CRUDE AND PROCESSED MAGNESITE, BY COUNTRY¹

Material and country	2006		2007	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Caustic-calcined magnesia:				
Canada	18,700	\$4,260	15,700	\$4,580
China	127,000	16,000	117,000	14,900
Greece	3,000	824	--	--
Hong Kong	12,600	2,160	--	--
Turkey	936	387	1,220	530
Other	190 ^r	273 ^r	23	57
Total	163,000	23,900	134,000	20,100
Dead-burned and fused magnesia:				
Australia	20,000	6,940	16,800	5,800
Austria	30,500	17,800	32,700	18,200
China	360,000	67,300	364,000	84,100
Greece	6,600	1,720	13,200	4,420
Israel	2,410	4,540	2,310	4,430
Japan	8,340	6,870	3,010	5,320
Korea, Republic of	1,140	587	--	--
Mexico	3,240	1,570	2,820	1,310
Other	1,070	521	1,860	1,120
Total	433,000	108,000	437,000	125,000
Other magnesia:				
Canada	1,040	294	2,780	933
China	1,920	761	4,610	1,740
Israel	261	443	572	872
Japan	1,190	2,360	940	1,960
Mexico	11,800	5,480	9,910	4,790
Slovakia	1,650	478	1,390	386
Other	1,230	1,280	694	817
Total	19,000	11,100	20,900	11,500
Crude magnesite:				
Brazil	759	188	575	238
China	7,900	996	4,070	652
Israel	2,820	588	2,120	619
Japan	2,790	579	1,960	629
Other	893	196	283	82
Total	15,200	2,550	9,000	2,220

^rRevised. -- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF MAGNESIUM COMPOUNDS¹

	2006		2007		Principal sources, 2007
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	
Magnesium chloride, anhydrous and other	64,400	\$12,100	49,100	\$10,100	Israel, 64%; Netherlands, 29%.
Magnesium hydroxide and peroxide	10,300	17,100	8,630	14,800	Mexico, 32%; Israel, 28%; Austria, 16%.
Magnesium sulfate, natural epsom salts	1,150	268	465	195	China, 73%; India, 22%.
Magnesium sulfate, natural kieserite	8,920	373	5,830	334	Germany, 100%.
Magnesium sulfate, other	22,200	5,980	28,300	8,390	Germany, 55%; Mexico, 18%; China, 17%.

¹Data are rounded to no more than three significant digits.

Source: U.S. Census Bureau.

TABLE 8
WORLD MAGNESIUM COMPOUNDS ANNUAL PRODUCTION CAPACITY,
DECEMBER 31, 2007^{1,2}

(Thousand metric tons, MgO equivalent)

Country	Raw material				Total
	Magnesite		Seawater or brines		
	Caustic- calcined	Dead- burned	Caustic- calcined	Dead- burned	
Australia	78	110	--	--	188
Austria	197	268	--	--	465
Brazil	83	351	--	--	434
Canada	50	--	--	--	50
China	275	2,940	--	10	3,230
France	--	--	30	--	30
Greece	120	100	--	--	220
India	20	296	--	--	316
Iran	--	30	--	--	30
Ireland	--	--	--	90	90
Israel	--	--	10	60	70
Italy	25	--	--	--	25
Japan	--	--	50	250	300
Jordan	--	--	10	50	60
Korea, North	--	1,100	--	--	1,100
Korea, Republic of	--	--	--	40	40
Mexico	--	--	15	95	110
Netherlands	--	--	10	150	160
Poland	--	10	--	--	10
Russia	100	2,400	--	--	2,500
Serbia	40	160	--	--	200
Slovakia	--	465	--	--	465
South Africa	12	--	--	--	12
Spain	145	60	--	--	205
Turkey	15	404	--	--	419
Ukraine	--	120	20	80	220
United States	140	--	201	195	536
Total	1,300	8,810	346	1,020	11,500

-- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Includes capacity at operating plants, as well as at plants on standby basis.

TABLE 9
MAGNESITE: WORLD PRODUCTION, BY COUNTRY^{1,2}

(Metric tons)

Country	2003	2004	2005	2006	2007 ^c
Australia	472,668	473,983	474,000	446,000 ^r	450,000
Austria, crude	767,000	715,000	694,000	700,000	700,000
Brazil, beneficiated	306,444	366,174	386,759	323,902 ^r	324,000 ^p
Canada ^{e,3}	180,000	180,000	180,000	180,000	180,000
China ^e	4,900,000 ^r	6,500,000 ^r	6,600,000 ^r	6,700,000 ^r	6,800,000
Colombia ^e	10,500	10,500	10,500	10,500	10,500
Greece, crude	549,049 ^r	499,474 ^r	475,670 ^r	500,000	500,000
India ^e	380,000	370,000	380,000	370,000	360,000
Iran	87,795	88,194	114,708 ^r	110,000 ^{r,c}	110,000
Korea, North ^e	1,000,000	1,200,000	1,200,000	1,200,000	1,200,000
Pakistan	2,645	6,074	3,029	4,000 ^e	4,200
Poland, concentrate	27,200 ^r	57,900 ^r	50,000 ^r	50,000 ^{r,c}	50,000
Russia ^e	1,200,000	1,200,000	1,100,000	1,200,000	1,200,000
Serbia, crude ^e	24,000 ^{r,4}	20,000 ^{r,4}	20,000 ^{r,4}	20,000 ^r	20,000
Slovakia, concentrate	397,259 ^r	404,776 ^r	447,700 ^r	555,710 ^r	600,000
South Africa	86,100	65,900	54,800	73,300 ^r	73,000
Spain	517,030	567,504	485,800	500,000 ^e	500,000
Turkey, run-of-mine	3,224,278	3,732,952	2,372,206 ^r	2,088,033 ^r	2,100,000
United States	W	W	W	W	W
Zimbabwe	1,333	749	893	900 ^e	500
Total	14,100,000 ^r	16,500,000 ^r	15,100,000 ^r	15,000,000 ^r	15,200,000

^cEstimated. ^pPreliminary. ^rRevised. W Withheld to avoid disclosing company proprietary data; not included in "Total."

¹World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Figures represent crude salable magnesite. In addition to the countries listed, Bulgaria produced magnesite, but output is not reported quantitatively, and available information is inadequate for formulation of reliable estimates of output levels. Table includes data available through May 15, 2008.

³Magnesitic dolomite and brucite.

⁴Montenegro and Serbia formally declared independence in June 2006 from each other and dissolved their union.