MAGNESIUM

By Deborah A. Kramer

Magnesium is the eighth most abundant element in the Earth's crust and the third most plentiful element dissolved in seawater. Magnesium metal is recovered from seawater and well and lake brines, as well as from such minerals as dolomite, magnesite, and carnallite.

U.S. production of primary magnesium in 1997 was 6% less than that in 1996 as imports increased to fill a greater share of domestic demand. Imports of magnesium increased by 40%, with Canada and Russia supplying 73% of the total. Russia supplied more than one-half of the imports of primary magnesium, and Canada supplied about three-fourths of the alloy imports. Aluminum alloying remained the largest end use for primary magnesium, accounting for about one-half of the total. Significant growth in the use of magnesium for diecasting resulted from continued interest by automotive manufacturers in replacing aluminum and steel components with magnesium alloy components.

The new magnesium production plant in Israel that was commissioned in 1996 began its first full year of operation. In addition, progress was made on proposed new plants in Australia, Canada, and Iceland during the year. If all these plants are completed and on schedule, then 168,000 tons of annual capacity would be added by 2002. In addition to these plants, a 50,000-ton-per-year magnesium plant was in the early stages of planning in Congo (Brazzaville). Current magnesium producers in Canada and China also plan to add capacity to existing plants; an additional 28,000 tons of annual capacity would be installed by 2000. These new plants and capacity increases are in response to growth projections of 15% per year for the use of magnesium by the automotive sector.

Legislation and Government Programs

The International Trade Administration (ITA) continued its administrative reviews of duties on magnesium from Canada. As a result, final countervailing duties were established for pure and alloy magnesium from Norsk Hydro Canada Inc., as follows: 9.86% ad valorem for the period from December 6, 1991, to December 31, 1992; 7.34% ad valorem for calendar year 1993; 4.48% ad valorem for calendar year 1994; and 3.18% ad valorem for calendar year 1995 (U.S. Department of Commerce, 1997b, c, d, e).

In the final results of an administrative review of antidumping duties assessed on magnesium imports from Canada, the ITA determined that the duty rate for Norsk Hydro Canada was 0% for the period from August 1, 1995, through July 31, 1996. This rate was effective for all U.S. imports for consumption of primary magnesium after publication of the results in the Federal Register (U.S. Department of Commerce, 1997f).

As a result of requests, the ITA will conduct administrative reviews of magnesium imports from Norsk Hydro Canada. The period covered under the antidumping duty review will be from August 1, 1996, to July 31, 1997, and the period for the countervailing duty review will be from January 1, 1996, through December 31, 1996. Final results of the reviews were expected to be issued by August 31, 1998 (U.S. Department of Commerce, 1997a).

In response to a request from Taiyuan Heavy Machinery Import and Export Corp., the ITA conducted a new shipper administrative review of the antidumping duty order for pure magnesium from China. Preliminary results of the review established a dumping margin of 83.92% for the company (U.S. Department of Commerce, 1997g).

On December 24, a three-judge panel of the U.S. Court of Appeals for the Federal Circuit remanded a case involving appeal of the antidumping duties for pure magnesium from Ukraine back to the Court of International Trade (CIT), finding no evidence that the U.S. industry was injured. The appeal was begun in 1995 by trader Gerald Metals. CIT is expected to consider the remand for several months before issuing a new decision. Antidumping duties from 79.87% to 104.27% had been established for pure magnesium from Ukraine in early 1995. The United States has not imported any magnesium from Ukraine since May 1994 (Platt's Metals Week, 1998).

Production

Primary magnesium production decreased by 6% from that of 1996. Increased imports of primary magnesium and magnesium alloys provided a greater portion of domestic demand at the expense of U.S.-produced material. *(See tables 1 and 2.)*

The trade press reported that Dow Chemical Co. was considering the sale of its magnesium division. The company retained Salomon Brothers as a financial advisor to help determine the best option for the magnesium operations. Sale of the division is only one of a number of options that the company is considering; at yearend, no decision was finalized (Platt's Metals Week, 1997c).

Consumption

Consumption of primary magnesium decreased slightly from the 1996 level. Aluminum alloying remained the largest end use for magnesium with about 50% of total primary consumption. This percentage declined from that of 1996, because of the significant increase in the use of magnesium alloy for diecasting. Increased auto industry usage of magnesium was responsible for the large increase is production of magnesium alloy diecastings. *(See tables 3 and 4.)*

Automotive industry analysts estimated that the average unit

content of magnesium diecastings in North American-built cars and light trucks will increase by 0.3 kilogram per vehicle from the 1997 model year to the 1998 model year. This increase represents an increase of 4,500 tons in total usage. The total magnesium content of each vehicle would average 2.9 kilograms (Wrigley, 1997a).

U.S. auto manufacturers continued to introduce magnesium alloy components in new vehicles; magnesium, however, was replaced in a few applications by aluminum. General Motors Corp. (GM) decided against switching from aluminum to magnesium in some of its transmission cases. GM said that it could achieve a weight reduction similar to that from magnesium substitution by designing aluminum cases with thinner wall sections than normal (Wrigley, 1997g).

GM announced plans to convert several automotive components to magnesium in 1997 and finalized plans to convert transfer cases in the 1998 models of some small pickup trucks and four-wheel drive sports utility vehicles from aluminum to magnesium. The transfer cases for GM will be manufactured by New Venture Gear Inc., and the application is expected to consume about 1,300 tons of magnesium alloy AZ91 annually (Wrigley, 1997e). GM also approved a two-piece magnesium instrument panel for the 1999 models of its Cadillac DeVille. This new component, along with other magnesium parts scheduled to be installed in this model, will bring total annual magnesium consumption for the Cadillac DeVille to 1,250 tons (Wrigley, 1997i). Canada-based Trimag Co. was selected as the supplier for GM's magnesium instrument panel support casting for its 2001 model sports utility vehicles. Each magnesium component will weigh about 3.6 kilograms, and annual consumption for this application was estimated to be about 1,700 tons of alloy AM60 (Wrigley, 1997d).

GM also announced that it would convert the steel instrument panel support beams to magnesium in the next generation models of its standard-size Buick, Oldsmobile, and Pontiac cars, beginning in summer 1999. This application represents a total annual consumption of 1,800 tons of magnesium. The magnesium alloy for this application, AM60, will be supplied by Norsk Hydro Canada with which GM has a long-term purchase agreement. Meridian Technologies Inc. will produce the one-piece castings at its plant in Strathroy, Ontario, Canada (Wrigley, 1997f).

Ford announced that it would convert most of the transfer cases in its four-wheel drive vehicles from magnesium to aluminum beginning in mid-1998. Cost was cited as the principal reason for the switch; list price for magnesium alloy AZ91 was about twice that of secondary aluminum alloy ingot A380.1. These transfer cases were estimated to account for about 20% of Ford's total magnesium consumption, or about 3,200 tons annually (Wrigley, 1997j).

Isuzu Motors Ltd. chose Harvard Industries Inc. to produce die-cast magnesium valve covers for the V-6 engines being produced in Japan. This application will require more than 270 tons of magnesium alloy AZ91 annually. Magnesium valve covers were expected to go into production later in 1997 (Wrigley, 1997h).

Ford announced plans to install enough magnesium components in its prototype high-mileage Partnership for a New Generation of Vehicles (PNGV) vehicle to account to about 10% of the total weight. The PNGV program, in which Ford, GM, and Chrysler Corp. are participating, is designed to mass-produce a six-passenger vehicle that can get 80 miles per gallon in fuel economy with a driving range of at least 380 miles. Total weight of the vehicle, which is expected to be introduced by 2004, will be nearly 1 ton, with 80% of the car's components recyclable (Wrigley, 1997b).

Because of the increase in magnesium alloys usage for automotive components, additional diecasting capacity in the United States was announced. Gibbs Die Casting Corp. announced plans to build a new 6,800-ton-per-year light alloy diecasting facility in Harlingen, TX. The new company, called Rio Grande Die Casting, will cast magnesium parts in a variety of alloys, including AM50, AM60, and AZ91. The Texas plant is expected to employ 100 workers and be operational by late 1998 (Wrigley, 1997c).

Diemakers Inc. completed installation of two 1,200-ton cold-chamber diecasting machines at its new Hanibal, MO, plant. One of the parts that these machines will be used to cast is a 20-inch digital satellite system television receiver (American Metal Market, 1997).

Data for magnesium metal are collected from two voluntary surveys of U.S. operations. Of the 85 companies canvassed for magnesium consumption data, 73% responded, representing 50% of the primary magnesium consumption listed in tables 1 and 3. Data for the 23 nonrespondents were estimated on the basis of prior-year consumption levels and other factors.

Stocks

Producers' yearend 1997 stocks of primary magnesium decreased to 13,100 tons from the yearend 1996 level of 17,400 tons. This represents less than 1 month of production at 1997 rates. Consumer stocks of primary and alloy magnesium decreased to 7,920 tons at yearend 1997; the 1996 yearend stocks were 8,720 tons. Yearend 1997 consumer stocks of secondary magnesium declined to 389 tons from the 1996 level of 572 tons.

Prices

Primary magnesium free market prices dropped during the first half of 1997, and then began to increase slowly for the remainder of the year. At the beginning of 1997, the Metal Bulletin free market price range was $2,400 to $2,650 per ton. By the beginning of March, this range had fallen to $2,300 to $2,500 per ton, its lowest level for the year. By yearend the quoted price was $2,425 to $2,625 per ton, about the same level as that at the beginning of the year. Prices quoted in other trade publications followed similar trends. The Metals Week European free market price was $2,600 to $2,700 per ton at the beginning of 1997; by yearend, the price range was $2,750 to $2,850 per ton. At the beginning of 1997, the Metals Week U.S. dealer import price range was $1.40 to $1.46 per pound and after dropping through March rose to $1.50 to $1.55 by yearend. The Metals Week U.S. spot Western price ranged from $1.70 to $1.80 per pound at the beginning of 1997 and, reversing the trend of the other prices, decreased slightly to $1.60 to $1.70 per pound by yearend.

Foreign Trade

Magnesium exports remained at essentially the same level as those of 1996. Canada (44%), the Netherlands (30%), and Japan (13%) were the principal destinations.

Total imports of magnesium increased by 40% from those of 1996. Canada (51%), Russia (22%), and China (14%) were the principal suppliers. In addition, with the opening of a new plant, Israel began shipping primary magnesium to the United States in 1997. The most significant increase was in imports of magnesium alloys, which rose by 66%. *(See tables 5 and 6.)*

World Review

The United States continued to lead the world in production and production capacity of primary magnesium, with about 32% of the world production and about 28% of total world capacity. *(See tables 7 and 8.)*

According to figures published by the International Magnesium Association (IMA), world magnesium shipments were 334,000 tons, a 13% increase from those of 1996. Aluminum alloying, with 44% of total shipments, was the largest end-use category for magnesium, followed by die casting with 29%, and desulfurization with 14%. Yearend 1997 world inventories decreased by 22%, to 32,900 tons (International Magnesium Association, 1998). The IMA also has established a site on the World Wide Web. The address is http://www.intlmag.org/. In addition to information about the IMA, the Internet site has links to some of IMA's member companies.

In September, the European Commission (EC) officially began an investigation into the dumping of unwrought, unalloyed magnesium from China. The complaint, originally filed on behalf of Pechiney of France in July, alleges that magnesium from China was dumped from the end of 1996 to the beginning of 1997 at an estimated margin of 50%. The EC requested that all parties who could show that they were likely to be affected by the investigation file written documentation by October 1. The EC will use Norway as an appropriate country to establish fair market value for the magnesium (Platt's Metals Week, 1997d).

Australia.—Queensland Magnesium Corp. (QMC) entered into a partnership with Ford, which was expected to provide enough funding for QMC to proceed with its pilot magnesium production plant. Under terms of the agreement, Ford will invest $30 million in a pilot-plant study and will gain a long-term contract for the eventual supply of 45,000 tons per year of magnesium. In addition to Ford, other investors will provide funding for a 2.5-year, precommercial phase to cover the construction and operation of a 1,000-ton-per-year demonstration plant and feasibility study; these other partners will hold no equity interest in the project. Total investment by all the partners was projected to be A$73 million. QMC expected to begin the precommercial phase in February and to commission the demonstration plant in early 1998. Commercial plant construction is expected to begin in mid-1999, with start-up by late 2002 (Platt's Metals Week, 1997g).

Canada.—Noranda Inc. approved the construction of a $513 million, 58,000-ton-per-year primary magnesium plant in Asbestos, Quebec, after operating a 250-ton-per-year pilot plant for more than 1 year. Plant construction is scheduled to begin in 1998, with commercial production to begin in mid-2000 (Platt's Metals Week, 1997h). The new plant, operated by Magnola Metallurgy Inc., will produce magnesium from asbestos tailings by a unique process. Typical analysis of the tailings is 40% MgO, 38% SiO_2, 5% Fe compounds [Fe_2O_3 and $Fe(OH)_2$] and 13% H_2O. This material is slurried and fed to a magnetic separator to remove iron impurities; then the tailings are continuously leached by a 33% hydrochloric acid solution. The leach overflow is partially neutralized to avoid silica gel formation, one of the major drawbacks to using silicate materials as feed for producing magnesium chloride brine. By carefully maintaining the pH of the slurry, base metal impurities are separated while avoiding magnesium precipitation. The slurry is filtered, and the impure brine produced is purified further by sparging with chlorine gas, and then fed through ion exchange columns to remove the remaining traces of the metal impurities. Purified brine is dehydrated in a fluid bed dryer. In the dryer, prills are formed that contain 1% to 2% MgO, which must be removed before being fed to electrolytic cells. This is done in a reactor where they are melted and contacted with hydrogen chloride gas. MgO-free magnesium chloride is electrolyzed in Alcan Multi-Polar Cells, and the magnesium produced is either cast into pure magnesium ingots or transferred to an alloying section where it is cast into alloy products (Brown, 1998).

Norsk Hydro A/S announced that it would double the annual capacity of its Becancour primary magnesium plant to 86,000 tons. Construction of the first phase of 25,000 tons per year of capacity is scheduled to begin in 1998, with completion expected in 2000. Construction of the second phase will start after the first phase is operational. A projected increase in magnesium demand by the automotive industry was cited as the reason for the expansion (Platt's Metals Week, 1997a).

Timminco Metals, Canada's producer of high-purity magnesium, planned to upgrade two extrusion presses and to expand extrusion capacity at its Haley, Ontario, plant in early 1998 (Platt's Metals Week, 1997l).

China.—China announced plans to increase annual capacity at the Minhe Magnesium Plant from 7,000 tons to 10,000 tons by early 1999. Investment for the upgrade will be $12 million. Minhe recently completed a 3,000-ton-per-year expansion, which began operating in July 1997 (Platt's Metals Week, 1997f).

Congo (Brazzaville).—Congo Minerals Inc. and Ashurst Technologies Inc. announced plans to produce magnesium in Congo (Brazzaville) by 2002. The two Canada-based firms acquired two exploration permits in the Kouili region for areas that contain substantial quantities of magnesium and potassium salts, mainly in the form of carnallite ($KCl \cdot MgCl_2 \cdot 6H_2O$). Carnallite reserves are estimated to be 8 billion tons containing about 8% magnesium. Congo Minerals is beginning to drill for bulk samples and plans to spend about $10 million to bring the project to a feasibility stage in about 18 months. At that point, the company will look for additional financing. Initial plans call for a 100,000-ton-per-year magnesium plant to be built near the mine; first-phase production capacity will be 50,000 tons per year. Ashurst is negotiating with Ukraine for electrolytic technology to be used in the proposed plant. Energy for the new plant will be supplied by existing onshore and offshore natural gas and potential hydroelectric power. Magnesium produced at

the new plant is expected to be marketed to the automotive industry (Metal Bulletin, 1997a).

At the end of October, Congo Minerals and Clavos Enterprises Inc. merged to form a new company, Magnesium Alloy Corp. Once this merger is finalized, the new company, along with Ashurst Technologies, plans to begin a prefeasibility study. The study, including drilling and analysis of samples, is expected to be completed within 12 to 18 months (Platt's Metals Week, 1997j).

Iceland.—Icelandic Magnesium Co. announced that its study confirmed the technical feasibility of constructing a 50,000-ton-per-year primary magnesium plant in Reykjanes. New technology that produces no byproduct chlorine and is adaptable to Icelandic conditions is expected to be supplied by a consortium of companies from the former Soviet Union. A decision to build a commercial plant is expected by yearend 1997 (Metal Bulletin, 1997b).

Israel.—By the end of April, Dead Sea Magnesium was operating 11 of its 60 electrolytic cells at it new primary magnesium plant in Sdom, and the company expected to produce 10,000 tons of magnesium in 1997. By December, the plant was expected to be operating at 80% of its 27,500-ton-per-year capacity (Platt's Metals Week, 1997b).

Israel's Ortal Diecasting Ltd. received an initial order from GM for V-8 engine parts in some pickup trucks and for parts in gear boxes. This order is estimated to be worth about $1 million over a 5-year period (Platt's Metals Week, 1997i).

Kazakstan.—The Ust-Kamenogorsk Titanium-Magnesium Works plans to resume magnesium production by the end of 1997. Ust-Kamenogorsk completed construction of a carnallite-processing facility in the third quarter and plans to start magnesium production at a level ranging from 5,000 to 10,000 tons per year in the fourth quarter. The magnesium plant has been idle since 1994, although the company has been producing titanium by recycling magnesium chloride (Platt's Metals Week, 1997e).

Russia.—Solikamsk Magnesium Works (SMW) commissioned a new magnesium granule plant in April. The new plant, a joint venture between SMW and German powder producer ALAMET GmbH, has a design capacity of 2,000 tons per year. Magnesium from the plant will be used for steel desulfurization in Russia. Construction of second and third stages, that will increase production capacity to 6,000 to 8,000 tons per year is dependent upon installation of desulfurizing equipment at some of the Russian steel producers (Platt's Metals Week, 1997k). Also in April, SMW began shipping magnesium to GM as part of a 5-year, $90 million contract that the companies signed at the end of 1996.

Current Research and Technology

As more magnesium alloys are die-cast for automotive applications, increased quantities of scrap will be generated; typically about 30% to 50% of metal consumed by diecasters ends up as scrap. Ideally, this scrap should be recycled into material that is directly usable by the automotive industry rather than as a lower grade material. Nonmetallic inclusions that have not been removed by the scrap-refining process limit the use of recycled magnesium in automotive applications. Researchers have developed a process to measure the nonmetallic inclusions that uses blue-light reflectance measurements on fracture surfaces . The reflectance, or brightness, measurements can be generated quickly and, as a result, have significant potential as a quality-control measurement for metal cleanliness (Grebetz and Haerle, 1997).

Engineers are developing magnesium alloy heat-storage elements for a new generation of automotive catalytic converters . The variable-conductance-insulation converter is a leading candidate to replace conventional catalytic converters as hydrocarbon and carbon monoxide emission standards become more stringent. The new converter is based on technology developed by the U.S. Department of Energy, and commercial versions of the converter are being developed by Benteler Automotive Corp., Grand Rapids, MI, for introduction in 3 to 5 years. If the new catalytic converter is installed with magnesium alloy, which would replace aluminum as a heat storage and dissipating material, then each North American-produced vehicle would require 1.4 to 1.8 kilograms of magnesium (Wrigley, 1997k).

Outlook

Changes in the automotive industry continue to be the driving force affecting the magnesium industry. Automobile manufacturers continue to switch components from aluminum or steel to magnesium alloy in an attempt to meet Corporate Average Fuel Economy standards. This has led to a significant increase in the demand for magnesium diecastings. Magnesium industry growth projections for this application are 15% per year; statistics from the IMA indicate that from 1991 to 1997, global demand for magnesium diecastings has increased from 24,000 to 64,000 tons, with a projected increase to 110,000 tons by 2001 (Clow, 1998?).

Without any increases in production capacity, magnesium supplies would be insufficient to meet the proposed increase in demand. As a result, several magnesium production facilities are either under construction, in development, or in the early stages of planning. The plant in Israel, which began its first full year of operation in 1997, has added 27,500 tons of annual capacity to the world magnesium industry. New capacity is planned for Australia, Canada, Congo (Brazzaville), and Iceland by 2005. Even if all the new projected capacity is not constructed, enough additional capacity should come on-stream to meet the additional needs.

As evidence of the automotive industry's commitment to magnesium, most of the large automotive manufacturers are either investing in the new plants or negotiating long-term contracts with current magnesium suppliers. Volkswagen AG has a stake in the new Israeli plant and will receive from 25% to 30% of the plant's production. Diecasters in North America are expanding or building new diecasting facilities to accommodate the increased demand. Additional scrap processing facilities are also being constructed in North America, and researchers are investigating ways to use recycled magnesium for automotive applications.

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TABLE 1
SALIENT MAGNESIUM STATISTICS 1/

(Metric tons unless otherwise specified)

	1993	1994	1995	1996	1997
United States:					
Production:					
Primary magnesium	132,000	128,000	142,000	133,000	125,000
Secondary magnesium	58,900	62,100	65,100	71,200 r/	80,200
Exports	38,800	45,200	38,300	40,500	40,500
Imports for consumption	37,200	29,100	34,800	46,600	65,100
Consumption, primary	101,000	112,000	109,000	102,000	101,000
Yearend stocks, producer	17,800	11,600	12,100	17,400	13,100
Price per pound 2/	$1.43-$1.46	$1.63	$1.93-$2.25	$1.70-$1.80	$1.60-$1.70
World: Primary production	269,000	282,000	395,000 r/	368,000 r/	392,000 e/

e/ Estimated. r/ Revised.
1/ Data are rounded to three significant digits, except prices.
2/ Source: Platt's Metals Week.

TABLE 2
U.S. MAGNESIUM METAL PRODUCERS, BY LOCATION, RAW MATERIAL,
AND PRODUCTION CAPACITY IN 1997

Company	Plant location	Raw material	Annual capacity (metric tons)
The Dow Chemical Co.	Freeport, TX	Seawater	65,000
Magnesium Corp. of America	Rowley, UT	Lake brines	40,000
Northwest Alloys Inc.	Addy, WA	Dolomite	40,000
Total			145,000

TABLE 3
MAGNESIUM RECOVERED FROM SCRAP PROCESSED IN THE UNITED STATES,
BY KIND OF SCRAP AND FORM OF RECOVERY 1/

(Metric tons)

	1996	1997
KIND OF SCRAP		
New scrap:		
Magnesium-base	8,040	8,480
Aluminum-base	33,100 r/	41,200
Total	41,100 r/	49,700
Old scrap:		
Magnesium-base	4,520	4,640
Aluminum-base	25,600	25,900
Total	30,100	30,500
Grand total	71,200 r/	80,200
FORM OF RECOVERY		
Magnesium alloy ingot 2/	W	W
Magnesium alloy castings	2,750	3,020
Magnesium alloy shapes	175	417
Aluminum alloys	59,100 r/	67,300
Zinc and other alloys	10	10
Other 3/	9,160 r/	9,440
Total	71,200 r/	80,200

r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Other."
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Includes secondary magnesium content of secondary and primary alloy ingot.
3/ Includes chemical and other dissipative uses and cathodic protection, as well as data indicated by symbol "W."

TABLE 4
U.S. CONSUMPTION OF PRIMARY MAGNESIUM, BY USE 1/

(Metric tons)

Use	1996	1997
For structural products:		
Castings:		
Die	14,700	20,000
Permanent mold	1,180	66
Sand	520	613
Wrought products 2/	8,080	6,840
Total	24,500	27,600
For distributive or sacrificial purposes:		
Aluminum alloys	52,300	50,000
Cathodic protection (anodes)	5,450	4,070
Chemicals	331	W
Iron and steel desulfurization	13,700	11,700
Reducing agent for titanium, zirconium, hafnium, uranium, and beryllium	2,340	3,120
Other 3/	3,630	4,060
Total	77,800	73,000
Grand total	102,000	101,000

W Withheld to avoid disclosing company proprietary data; included with "Other."
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Includes extrusions, sheet and plate, and forgings.
3/ Includes nodular iron, scavenger, deoxidizer, and powder.

TABLE 5
U.S. EXPORTS OF MAGNESIUM, BY COUNTRY 1/

	Waste and scrap		Metal		Alloys (gross weight)		Powder, sheets, tubing, ribbons, wire, other forms (gross weight)	
Country	Quantity (metric tons)	Value (thou-sands)	Quantity (metric tons)	Value (thou-sands)	Quantity (metric tons)	Value (thou-sands)	Quantity (metric tons)	Value (thou-sands)
1996:								
Australia	--	--	3,120	$9,730	10	$45	19	$67
Belgium	9	$23	2,940	12,200	656	1,670	728	2,260
Canada	8,360	20,500	24	84	4,830	17,500	860	4,880
Japan	6	15	5,410	17,400	123	532	486	4,910
Korea, Republic of	25	64	67	198	18	378	1,140	1,580
Mexico	9	23	373	1,570	36	253	3,180	542
Netherlands	20	45	4,810	13,300	1,100	3,360	902	2,550
Other	67	201	289	2,860	200	2,140	661	3,930
Total	8,500	20,900	17,000	57,300	6,970	25,900	7,970	20,700
1997:								
Australia	--	--	1,690	4,860	--	--	2	59
Belgium	--	--	65	186	1	17	179	470
Canada	11,000	25,100	480	1,700	5,430	19,400	721	3,730
Japan	121	299	4,580	12,300	235	971	374	3,280
Korea, Republic of	--	--	3	19	156	585	244	985
Mexico	12	55	371	1,150	136	602	521	725
Netherlands	42	89	8,970	22,100	2,540	6,580	447	1,300
Other	26	64	954	4,980	681	5,070	472	4,140
Total	11,200	25,600	17,100	47,300	9,180	33,200	2,960	14,700

1/ Data are rounded to three significant digits; may not add to totals shown.

Source: Bureau of the Census.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF MAGNESIUM, BY COUNTRY 1/

Country	Waste and scrap		Metal		Alloys (magnesium content)		Powder, sheets, tubing, ribbons, wire, other forms (gross weight)	
	Quantity (metric tons)	Value (thou-sands)	Quantity (metric tons)	Value (thou-sands)	Quantity (metric tons)	Value (thou-sands)	Quantity (metric tons)	Value (thou-sands)
1996:								
Brazil	133	$457	717	$2,860	36	$124	--	--
Canada	1,460	3,230	1,130	4,830	20,900	74,700	1,050	$5,460
China	57	131	171	467	1,680	4,540	52	144
Israel	--	--	--	--	--	--	--	--
Mexico	364	642	521	1,880	193	694	158	602
Russia	--	--	14,400	47,100	1,170	4,470	14	58
United Kingdom	311	666	163	450	363	3,320	2	193
Other	1,020	2,540	219	856	277	1,860	(2/)	7
Total	3,340	7,660	17,300	58,500	24,600	89,700	1,280	6,470
1997:								
Brazil	234	638	579	1,600	--	--	--	--
Canada	2,220	4,430	1,210	4,930	29,700	106,000	301	1,830
China	207	260	2,190	5,330	6,860	17,600	49	140
Israel	19	28	3,360	10,600	--	--	--	--
Mexico	15	18	634	2,580	324	1,130	158	641
Russia	--	--	11,100	28,100	3,410	10,900	--	--
United Kingdom	372	258	9	26	318	3,260	2	274
Other	930	1,070	542	1,530	375	2,390	(2/)	42
Total	3,990	6,700	19,700	54,700	41,000	141,000	510	2,930

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 7
WORLD ANNUAL PRIMARY MAGNESIUM
PRODUCTION CAPACITY, 1/ DECEMBER 31, 1997,
BY CONTINENT AND COUNTRY 2/

(Metric tons)

Continent and country	Capacity
North America:	
Canada	49,000
United States	145,000
Total	194,000
South America: Brazil	10,600
Europe:	
France	17,000
Kazakstan 3/	65,000
Norway	35,000
Russia 3/	82,000
Serbia and Montenegro	5,000
Ukraine 3/	54,000
Total	258,000
Asia:	
China	32,400
India	900
Israel	27,500
Total	60,800
World total	523,000

1/ Includes capacity at operating plants, as well as at plants on standby basis.
2/ Data are rounded to three significant digits; may not add to totals shown.
3/ Includes magnesium production capacity that is used exclusively for titanium production, as follows: Kazakstan, 40,000 tons; Russia, 35,000 tons; and Ukraine, 15,000 tons.

TABLE 8
MAGNESIUM: WORLD PRIMARY PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country	1993	1994	1995	1996	1997 e/
Primary production:					
Brazil e/	9,700	9,700	9,700	9,000	9,000
Canada e/	23,000	28,900	48,100	54,000	57,700
China e/	11,800	24,000	93,600	73,100 r/	92,000
France	10,982	12,280	14,450	14,000 e/	12,000
Israel	--	--	--	--	8,000
Japan	7,471	3,412	--	--	-- 3/
Kazakstan e/	2,000	-- 3/	9,000 r/	9,000 r/	8,972 3/
Norway	27,300	27,635	28,000 e/	28,000 r/ e/	28,000
Russia e/ 4/	30,000	35,400	37,500	35,000	39,500
Serbia and Montenegro	-- e/	--	2,560	2,500 e/	2,500
Ukraine e/	14,900	12,000	10,000 r/	10,000 r/	10,000
United States	132,000	128,000	142,000	133,000	125,000 3/
Total	269,000	282,000	395,000 r/	368,000 r/	392,000
Secondary production:					
Brazil e/	1,600	1,600	1,600	1,600	1,600
Japan	13,215	19,009	11,767	21,243 r/	22,797 3/
U.S.S.R. e/ 5/	6,000	5,000	6,000	6,000	NA
United Kingdom e/ 6/	1,000	1,000	1,000	1,000	1,000
United States	58,900	62,100	65,100	70,200 r/	80,200 3/
Total	80,700	88,700	85,500	100,000 r/	106,000

e/ Estimated. r/ Revised. NA Not available.

1/ World totals and estimated data are rounded to three significant digits; may not add to totals shown.

2/ Table includes data available through July 22, 1998.

3/ Reported figure.

4/ Includes secondary.

5/ Dissolved in December. 1991; however, information is inadequate to formulate reliable estimates for individual countries of the former U.S.S.R..

6/ Includes alloys.