Magnesium

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World production of primary and secondary magnesium increased to an estimated 579 000 t in 1999, up 3% from a revised estimated figure of 561 000 t in 1998.[1] Consumption figures for magnesium were not published in 1999 by the International Consultative Group on Nonferrous Metals Statistics. Prices for magnesium generally weakened during the year, due mainly to the continued high levels of shipments from China.

The International Magnesium Association (IMA) reports that Western primary magnesium production (which excludes China, the former Soviet Union and Israel) decreased by 8% (19 900 t) in 1999 to 252 200 t. That decrease was due to the closure of The Dow Chemical Company's plant in the United States. Exports from Russia, China and the Ukraine continued to be strong in 1999. Imports and the withdrawal of supplies from unreported inventories made up for the decreased production in North America during the year.

The IMA also reported that shipments of primary and secondary magnesium in North America from primary producers remained strong with 215 200 t shipped in 1999 compared to the 210 700 t shipped in 1998. This increase in shipments reflected increased demand in the die-casting and electrochemical sectors. North America (57%) and Western Europe (27.5%) are the largest consumers. (Further information from the Association can be obtained on the Internet at http://www.intlmag.org.)

IMA data also indicate that inventories of primary magnesium increased in 1999 to 45 900 t at year-end compared to 44 300 t at the end of 1998. This 1999 inventory represents approximately 35 days of world production of primary magnesium.

CANADIAN DEVELOPMENTS

Norsk Hydro Canada Inc. (Norsk Hydro), a wholly owned subsidiary of Norsk Hydro ASA of Norway, produces magnesium metal at a 43 000-t/y Bécancour, Quebec, plant using an electrolytic process. The plant also recycles magnesium scrap produced by its customers. In November 1999, the Bécancour operation celebrated its 10th year of production. The company had announced in 1997 that it would study a two-phase expansion project to double capacity at the plant. Norsk Hydro completed its studies in 1999 and decided not to increase the plant's nameplate capacity at this time but, rather, to focus on debottlenecking the existing operations and making them more efficient. Expansion may take place in the future provided sufficient customer contractual commitments for the production are in place.

Norsk Hydro's magnesium direct-chill, T-bar casting unit at Bécancour was damaged in an explosion in January. The company announced in August that it would not rebuild the unit as it had developed a new ingot product to replace its large T-bar shapes for use in alloying aluminum. The new ingot is available in both 250-lb and 250-kg shapes. The company has also developed a new alloy for which it is seeking patents. The alloy, for use in environments with elevated temperatures, was expected to be available in early 2000. (Further information on Norsk Hydro can be obtained on the Internet at http://www.magnesium.hydro.com.)

Timminco Limited produces high-purity metal (up to 99.98% pure) for specialized market applications at its 6000-t/y magnesium plant at Haley Station, Ontario. The company also produces highly corrosion-resistant magnesium die-casting alloys and extruded anode rods for hot-water heaters. Timminco's magnesium products are used for a variety of applications such as alloying agents for aluminum and calcium, in Grignard reagents for the pharmaceutical industry, and in electronic products. Timminco uses the Pidgeon magnesium process in which calcined dolomite is reduced by ferrosilicon in

[1] Magnesium statistics vary between sources. Data in this review are therefore a consolidation of multiple sources and must be considered provisional.

a vacuum retort. Timminco mines the dolomite at the plant site but purchases the ferrosilicon feed on the open market.

In 1999, Timminco continued a program to address the company's capacity limitations in its production and extrusion plants in Ontario. The company completed expansion of its Haley extrusion plant, improved casting capabilities, and completed construction of a new granulation facility. The casting facility at Haley will initially provide magnesium billets for Timminco's extrusion facilities at Haley Station, Ontario, and Aurora, Colorado. On a long-term basis, the company intends to expand operations in the wrought products area.

In 1998, Magnola Metallurgy Inc. (owned 80% by Noranda Inc. and 20% by Société générale de financement du Québec) started construction of its 63 000-t/y commercial magnesium plant in Danville, Quebec. Magnola Metallurgy Inc. cast its first magnesium ingot at a pilot plant in Salaberry-de-Valleyfield, Quebec, in March 1997. The ingot was the first of its kind and was produced by an innovative process that was developed over the last 10 years by researchers at the Noranda Technology Centre. Noranda's proprietary process allows for the production of magnesium metal from the mining residues of local asbestos mines. The plant is expected to be the world's lowest-cost producer of magnesium.

Construction of Magnola's $733 million plant was on schedule at year-end. Approximately 650 workers, on the site since April 1998, had completed construction of the buildings and support structures by the end of 1999. At year-end, installation and testing of mechanical and electrical equipment was under way. The plant was expected to produce its first metal in mid-2000 and to reach full commercial production at the end of 2001. In addition to the construction work generated by the project, nearly 350 direct permanent jobs will be created by the operation of the plant. (Further information on Magnola is available on the Internet at http://www.magnola.com.)

In Canada, as in the rest of the world, there has been continued interest in the production of magnesium metal from dolomite deposits or from previously mined asbestos deposits. The Canadian projects include: Gossan Resources Limited at Inwood, Manitoba; Cassiar Mines and Metals Inc. at Cassiar, British Columbia; and Canadian Magnesium Corporation at Baie Verte, Newfoundland.

Gossan Resources Limited has a dolomite property at Inwood, Manitoba, with a dolomite resource estimated at 67 Mt grading 21.6% magnesium oxide. Tests on this material have shown that production of commercial-grade magnesium metal using the Magnetherm process is possible. Gossan focussed its efforts on other projects in 1999 but, after discussions with other magnesium metal producers, plans to proceed with a marketing study. (Further information on Gossan Resources is available on the Internet at http://www.gossan.ca.)

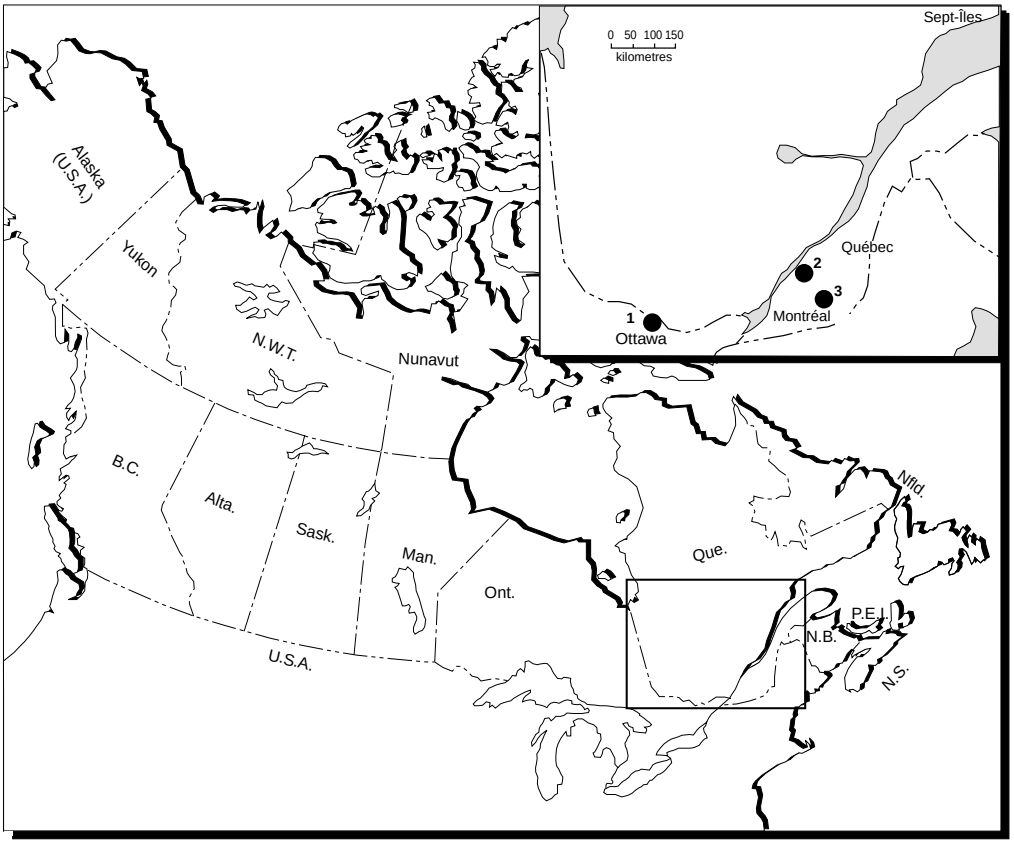
Cassiar Magnesium Inc. (formerly Cassiar Mines and Metals Inc.) signed a Memorandum of Understanding with Aluminium of Korea Ltd. (Koralu) for the development of Cassiar's magnesium metal project at Cassiar, British Columbia. Koralu can acquire a 35% interest in the project by funding a US$25 million feasibility study and may increase its interest to 65% by funding the project to commercial production. A feasibility study for a 90 000-t/y, $900 million plant is expected to be completed in 2000. The metal project could be carried out in addition to the company's project currently under way to recover asbestos fibres at the former Cassiar Asbestos Corporation Limited's asbestos mine at Cassiar in northern British Columbia. (Further information on the project can be found on the company's web site at http://www.minroc.com.)

Canadian Magnesium Corporation (CMC) has proposed a project to extract magnesium oxide from serpentine in the tailings at the former Baie Verte asbestos mine in Newfoundland. The company received a mineral lease in 1998 from the Newfoundland government. In 1999, CMC completed prefeasibility studies and bench-scale testing on mineral residues. Results of the work were positive and indicated that a clean product could be produced. The company is reviewing its financing options prior to committing to piloting and marketing studies.

Hydro-Terra, a Montréal-based company, formed a new joint-venture company called CellMag Inc. with Énergie Capital, a venture capital fund created by Hydro-Québec and Fonds de solidarité des travailleurs du Québec. CellMag announced in June 1999 that it had developed an alternate, energy-efficient method of producing magnesium by electrolysis. In this process, hydrogen chloride gas is formed at the anode instead of forming chlorine gas by feeding hydrogen to the cell. This process requires 25% less energy to reduce the magnesium. The process also allows the chlorine to be easily recycled and results in less sludge and less chlorinated hydrocarbons. The company will conduct further tests and intends to optimize the process in 2000. (Additional information is available on the company's web site at http://www.hydroterra.com/en/index.html.)

Canadian magnesium production data are confidential due to the limited number of companies reporting. Figures quoted in Table 3 are those estimated by the U.S. Geological Survey and provided to the International Consultative Group on Nonferrous Metals Statistics. These estimates include recycled magnesium.

Figure 1
Magnesium Smelters, 1999



SMELTER	COMPANY	CAPACITY (t/y)
1. Haley Station, Ontario	Timminco Limited	6 000
2. Bécancour, Quebec	Norsk Hydro Canada Inc.	43 000
3. Danville, Quebec (proposed)	Magnola Metallurgy Inc.	63 000

WORLD DEVELOPMENTS

The most important factor in the world magnesium market situation continues to be the increased production (and exports) of magnesium from China. Production from China has rapidly increased over the past nine years from about 5000 t in 1990 to 157 000 t in 1999, as reported by the China Magnesium Association. This increase has resulted in a decrease in the price of magnesium, especially in markets that are not protected by tariff barriers. Continued availability of this lower-priced magnesium may eventually result in the increased use of magnesium and the development of new uses.

The second most important factor in the magnesium market is the large number of proposed new projects and expansions of existing operations. If only a few advance to fruition, global primary magnesium metal production would expand considerably. While it is unlikely that all of these projects will proceed, it is likely that magnesium supplies could be available for an accelerated rate of growth in demand should prices not decrease substantially from their present levels.

In 1999, increased demand in the die-casting sector again led the way to record magnesium shipments. According to the IMA, shipments of primary magnesium from producers in 1999 were a record 375 500 t, up 4.2% over the 1998 record of 360 300 t. Shipments for die casting were up 25% over 1998 and shipments for electro-chemical applications were up 22%. These increases more than made up for the decreases in magnesium used for desulphurization and other uses.

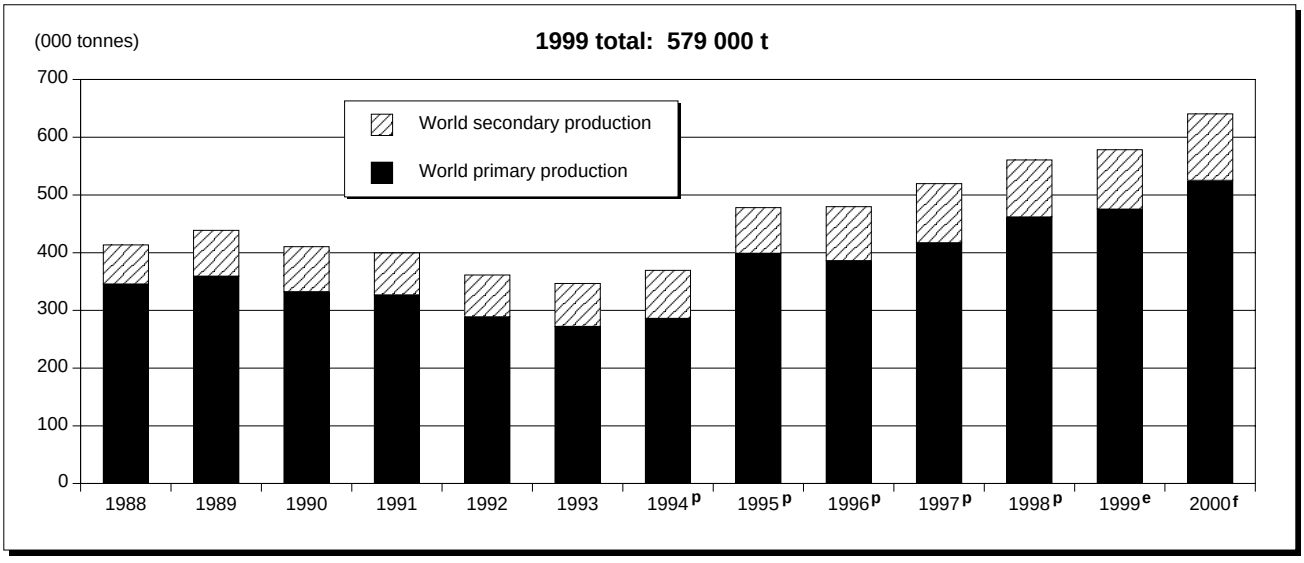
The IMA has said that, in 2000, it will change its definition of "shipments" of magnesium to exclude shipments of recycled magnesium. As a result, the amounts shipped will decrease next year, particularly for die-casting shipments, which in the past have contained some shipments of reworked clean scrap returned to some primary facilities by die-casting operations.

United States

At the end of 1999, the United States had two operating primary magnesium smelters. These were Magnesium Corporation of America (Magcorp), which operates a 43 000-t/y electrolytic plant in Rowley, Utah, and Northwest Alloys, Inc., which operates a 38 000-t/y silicothermic magnesium plant in Addy, Washington.

Magcorp, a wholly owned subsidiary of Renco Metals, Inc., concentrates brine from the Great Salt Lake in Utah to produce a magnesium chloride feedstock. The resulting magnesium chloride is then reduced to metal in electrolytic cells. The metal is then refined and cast into various products. The company continued to work on an upgrading program that began in 1997 to develop a more efficient electrolytic cell technology to meet new environmental standards for chlorine emissions. However, in 1999, Magcorp scaled back plans to convert its cells due to technical and financial constraints. The conversion of cells was

Figure 2
World Production of Primary and Secondary Magnesium, 1988-2000



Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics; China Magnesium Association.
e Estimated; f Forecast; p Preliminary.

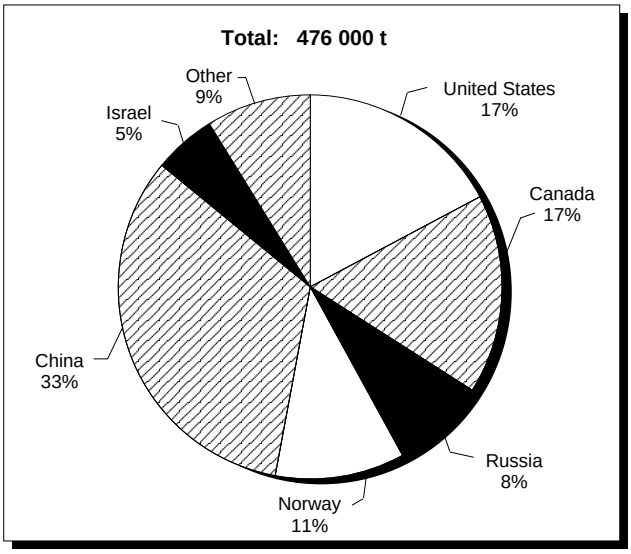
delayed by at least a year and is now expected to start in the second half of 2000. Once started, the conversion is expected to reduce Magcorp's metal production over the subsequent two years required to complete the work.

Magcorp also installed a new magnesium caster to improve product quality and produce custom shapes at a lower cost. The company has increased its involvement in casting and, as a result, has become increasingly involved in recycling scrap magnesium. Magcorp has a site on the Internet at http://www.magnesiumcorp.com.

Northwest Alloys, Inc., a subsidiary of Alcoa Inc., uses the Magnetherm silicothermic process at its Addy plant to produce magnesium by reducing dolomite with ferrosilicon. Northwest Alloys awarded a contract to Mintek to build a 1.5-MW furnace for magnesium smelting. The goal of the program is to study the production of magnesium by carbothermic reduction, a process that uses carbon to reduce magnesium compounds to produce magnesium metal. The bulk of Northwest Alloy's production is shipped for use by Alcoa subsidiaries in aluminum alloys.

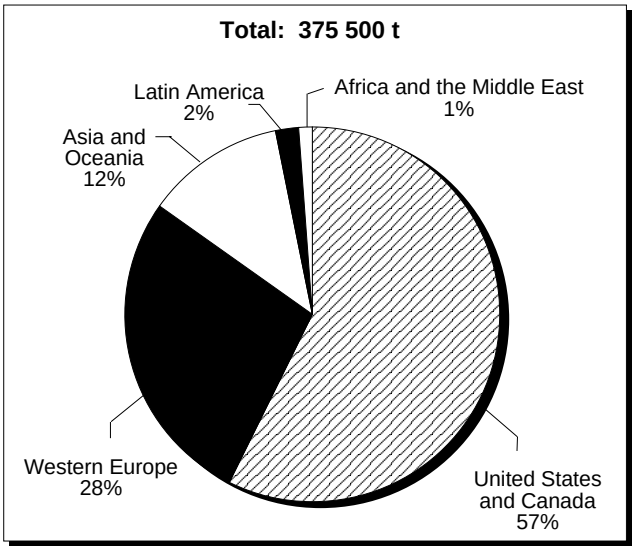
In early 2000, Xstrata AG purchased magnesium scrap processing technology from JCD Ltd. JCD has a process to make high-purity alloys from magnesium scrap. Xstrata started a feasibility study for its first scrap recycling facility in the mid-western United States. The study for the 25 000-t/y plant was expected to be completed by mid-2000. Xstrata's future plans include possible additional plants in Europe and Asia.

Figure 3
World Primary Magnesium Production,[e] 1999



Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics; China Magnesium Association.
[e] Estimated.

Figure 4
Magnesium Shipments by World Zone, 1999[e]



Source: International Magnesium Association.

The U.S. Department of Commerce's International Trade Administration (ITA) completed two separate administrative reviews of the anti-dumping duty on imports of pure magnesium into the United States from Norsk Hydro Canada Inc. during the periods August 1, 1996, to July 31, 1997, and from August 1, 1997, to July 31, 1998. The reviews resulted in setting dumping margins at 0% for the review periods. Due to limited commercial sales in the three consecutive years preceding the request, the ITA determined that the duties would not be revoked. The Department also conducted an administrative review of countervailing duty orders on pure and alloy magnesium for the period from January 1, 1997, to December 31, 1997, and set the rate for the period at 2.02%. The ITA also started a review of pure and alloy magnesium imports during 1998, as well as a full sunset review for pure and alloy magnesium (*The Uruguay Round Agreements Act* requires the U.S. Department of Commerce and the U.S. International Trade Commission (ITC) to conduct these sunset reviews no later than five years after an anti-dumping or countervailing duty order is issued.) Preliminary results of the sunset review, published in early 2000, imposed a rate of 1.84% on imports from Norsk Hydro. (Additional information can be obtained on the Internet at http://www.usitc.gov.)

In 1995, the ITC imposed anti-dumping duties ranging from 74.87% to 104.27% on pure magnesium from

the Ukraine. The duties were appealed to the U.S. Court of Appeals in 1995 and the case was remanded back to the Court of International Trade (CIT) in 1997. In 1998, the CIT upheld the decision that the U.S. magnesium industry is not injured by imports from the Ukraine. On August 17, 1999, after a determination that the U.S. industry was not being materially injured or threatened by the imports, the Department of Commerce announced that it had revoked the anti-dumping duty order on pure magnesium from the Ukraine effective August 24, 1999, applying to imports on or after October 30, 1998. (Further information can be obtained on the Internet at http://www.access.gpo.gov or at http://www.ita.doc.gov.)

In 1999, the ITA started a review of the anti-dumping duty order on sales of pure primary magnesium from China's Taiyuan East-United Magnesium Company Ltd. for the period of May 1, 1998, through April 30, 1999. (The duties had been set at 69.53% in 1996.) However, the review was terminated in December after the importer withdrew the request for review. (Further information can be obtained on the Internet at http://www.usitc.gov or at http://www.ita.doc.gov.)

The ITC voted on November 4, 1999, to conduct full five-year "sunset" reviews concerning the countervailing duty and anti-dumping duty orders on pure and alloyed magnesium from Canada. In early 2000, the ITC also published a notice that it had instituted a review of anti-dumping duty orders on imports of pure magnesium from Russia and China issued in 1995.

Additional information on magnesium production in the United States, as well as other general information on magnesium, is available on the U.S. Geological Survey's Internet site at http://minerals.er.usgs.gov.

Europe

In 1999, Icelandic Magnesium Co. continued studies for a proposed 50 000-t/y smelter in **Iceland**. The work included studies on possible feed and energy sources, and port and site alternatives. As Australian Magnesium Corporation (AMC) owns 40% of the company, the decision on plant construction will likely only be made after technical work on AMC's magnesium project is completed (see section on Australia).

In 1998, the Antheus Magnesium Project Group proposed a new magnesium plant in the Eemsmond region in Delfzijl metal park in the northeastern **Netherlands**. The Project Group includes: Nedmag Industries Mining and Manufacturing, a producer of dead-burned magnesia and other magnesium compounds; Corus Aluminum; Northern Netherlands Development & Investment Co.; and the Netherlands Ministry of Economic Affairs. The group completed a pre-feasibility study in 1999 and submitted it to the Dutch government in early 2000. The Group intends to conduct a full feasibility study in 2000. The proposed magnesium plant could have a capacity of 15 000-60 000 t/y and would use magnesium salts produced by Nedmag. The Group expects a decision on construction of a plant in 2001 that could be operational in 2005.

European Community Council Regulation 2402/98, dated November 8, 1998, had imposed an anti-dumping duty on imports of unwrought unalloyed magnesium originating from China. The ruling lowered the minimum price to 2622 European Currency Units (ECU) per tonne for unwrought unalloyed magnesium from a provisional price of 2797 ECU/t established in May 1998. The duty will be the difference between the minimum import price of 2622 ECU/t and any lower c.i.f. community frontier price. All other cases are subject to an ad valorem duty of 31.7%. (Additional information is available on the Internet at http://europa.eu.int.)

In 1999, the European Commission (EC) again investigated imports of unwrought unalloyed magnesium imports from China following a complaint by Euroalliages (the European alloys association) on behalf of Pechiney SA for its wholly owned subsidiary, Pechiney Électrométallurgie of France. Pechiney is the sole producer of magnesium within the European Union. The EC is expected to complete this anti-dumping investigation in 2000.

With the increasing use of magnesium and the demand for recycling, a number of European facilities have been expanded or have announced the construction of new recycling facilities. These include:

- Norsk Hydro A/S doubled its recycling capacity at its subsidiary, Norsk Hydro Magnesiumgesellschaft mbH, in Bottrop, **Germany**, to 4500 t/y from 2200 t/y and has obtained permits for an expansion to 9000 t/y. The plant is capable of handling both clean and painted scrap as well as drosses.

- Magnesium Elektron (a member of the Luxfer Group) announced plans to increase recycling at its Manchester operation in the **United Kingdom** by 3000 t/y and to construct a new state-of-the-art plant in **Germany**. The German facilities are expected to be in operation in late 2000 and will have an initial capacity of 10 000 t/y. Plans include an increase in capacity to 20 000 t/y when volumes of recycled metal increase. (Further information is available on the Internet at http://www.luxfer.com.)

Russia

In 1999, Solikamsk Magnesium Works completed a feasibility study to expand facilities at Solikamsk in

the Perm region. The company announced in early 2000 that it would construct a new US$95 million facility to increase its magnesium and magnesium alloy capacity by 15 000 t/y to bring its capacity to 45 000 t/y. The company planned to obtain funds from existing shareholders and bank loans. In 1999, Solikamsk sought credit from the European Bank for Reconstruction and Development (EBRD) and other banks for the expansion. The construction of the plant would take three years. The new plant would use a new process developed in cooperation with the Russian Titanium & Magnesium Institute, based on one used at Solikamsk. The new process would use a feed of synthetic carnallite produced from magnesium oxide with a brucite source for the magnesium oxide. The company also studied the production of magnesium metal from asbestos tailings at the JSC Uralasbest asbestos mine in the Sverdlovsk region.

Russia's other primary magnesium producer is the Avisma Titanium-Magnesium Works at Berezniki, also in the Perm region. Avisma announced plans to increase the production of magnesium and magnesium alloys to 18 000 t/y and to increase its production capacity by 5000-7000 t annually to reach a capacity of 40 000 t/y by 2002. The company investigated the use of alternate source feeds for the magnesium production because it is planning to convert from a feed of natural carnallite to a process using synthetic carnallite to avoid the production of excess chlorine. The company's new process, planned for introduction in 2000, would also use brucite to produce the synthetic carnallite and is expected to reduce costs. The brucite would be sourced in the Khabarovsk district of eastern Russia where it is mined for the production of refractory materials. In conjunction with its expansion plans, Avisma was reported to have signed a renewable three-year agreement with Alcan to supply magnesium for use in alloys used for rolled and foil products. The company planned to produce 23 500 t of magnesium and magnesium alloys in 2000.

JSC Uralasbest, in the Sverdlovsk region, tested the extraction of magnesium from its asbestos tailings in a pilot plant and proposed a US$300 million plant to produce 50 000 t/y of magnesium. The technology, which would be used for the production of magnesium at the company's asbestos mine, was developed at the Solikamsk Magnesium Works.

Ukraine

In 1999, the Ukraine government turned the Zaporozhye State titanium and magnesium plant into a public enterprise. Zaporozhye has a capacity to produce 45 000 t/y of magnesium.

The Ukraine's other magnesium plant, the Kalush Potassium and Magnesium Works in the Ivano-Frankovsk region, closed in January 1999. During the year, the company looked for additional funding to re-open and expand the plant after the United States removed anti-dumping duties of 80-100% on Ukrainian magnesium that had been imposed in 1993. The removal of these duties followed a long process and the company now wishes to re-open and expand production.

Kazakstan

The Government of Kazakstan announced in 1999 that it planned to privatize its remaining ownership in the Ust-Kamenogorsk Titanium and Magnesium Combine in 2000. The plant has produced magnesium for use in the production of titanium but has not produced significant quantities of magnesium since early 1994. This privatization is part of a state program to privatize a number of state-owned companies. (Additional information is available on the company's Internet site at http://www.kazinvest.com/eng/success/bluechip/uktmk.htm.)

Israel

Late in 1999, Dead Sea Magnesium Ltd. (DSM) was restructured and became a subsidiary of Israel Chemicals Ltd. when Israel Chemicals and Volkswagen AG provided another US$100 million of funding. The funds will be used to reduce debt, make improvements in the plant, and enable increased production of alloys. Approximately US$500 million has now been invested in the plant, including approximately $160 million in grants from the Israeli government. Dead Sea Magnesium Ltd. originally was a joint venture of Dead Sea Works Ltd. (DSW) of Israel (65%) and Volkswagen AG of Germany (35%).

DSM completed its third full year of operation at its plant at Sdom, Israel. Although it had experienced some difficulty in bringing the plant on line and with financing, production rates have now stabilized and the company has sold magnesium production beyond its commitments to Volkswagen. DSM expected to sell more magnesium in 1999 than it produced as stockpiles were reduced.

During the year, DSM changed from a batch process to a continuous flow process and continued to remove bottlenecks in the operation. The plant produced about 30 000 t in 1999 and the company expected to increase its production incrementally to 34 000 t/y by 2002. The company was also considering construction of a die-casting plant in Dimonea, 40 km from the smelter, but has postponed the construction until 2001 when the metal plant is expected to become more profitable. (Additional information is available on the Internet at http://www.dsw.co.il.)

United Arab Emirates

In 1999, a joint venture comprising the Sahari Group of Abu Dhabi and Normans of Albania proposed the construction of a 20 000-t/y smelter in the Hamriyah Free Zone in Sharjah in the United Arab Emirates on the coast of the Gulf of Oman. During the year the partners sought funding and additional investors.

Asia

Japan

Japan has no primary magnesium production but does have companies that recycle magnesium scrap to produce secondary magnesium. As was the case elsewhere in the world, there was increased interest in the recycling of magnesium in Japan as increasing amounts of consumer products containing magnesium reached the end of their life. In Japan, a new law will take effect in April 2001 that requires manufacturers to take back appliances, whether imported or manufactured. As a result, there has been an interest in recycling the metals in such appliances, including magnesium. New plants and expansions have included:

- Nippon Kinzoku Co. Ltd., which produces magnesium die castings, planned to increase its capacity for recycling magnesium from 2200 t/y to 4800 t/y; and

- Morimura Brothers Inc., Norsk Hydro's magnesium agent in Japan, and Onoda-Shoten Co. opened a 1200-t/y magnesium recycling facility in Gifu Prefecture. The partners plan to double the size of the plant as conditions warrant.

China

As a result of the rapid development of China's primary magnesium industry and the limited demand in its domestic market, China has become a major exporter of primary magnesium to the Western World in recent years. China has increased from almost no exports in 1990 to more than one third of world primary shipments in 1999. Global Trade Information Services, Inc., the publisher of the World Trade Atlas, reports that exports of primary magnesium totaled almost 100 000 t in 1998 and increased to almost 140 000 t in 1999. Since the United States imposed anti-dumping duties on China's unwrought magnesium, China's primary magnesium exports have been mainly focussed on European and Japanese markets.

China's magnesium metal production capacity, in approximately 500 plants, has been estimated at approximately 200 000 t/y. As most magnesium plants in China use a batch silicon thermal reduction process, the opening and closing of plants is relatively easy. In addition, the cost of ferrosilicon, an essential input into the production process, was relatively low within China, giving Chinese magnesium producers a cost advantage. However, power costs have started to increase in late 1999 and early 2000 in some parts of China, and that advantage may be reduced somewhat in the future. Government initiatives to reduce environmental damage from plants have resulted in a reduction in the number of loans to the smallest magnesium producers, and that too may result in a longer-term reduction in the number of small producers.

Due to the current low prices for Chinese magnesium, many plants are currently closed, but these could be re-opened should prices rise. About 50 plants were reported to be in production at the end of 1999 and production in 1999 was reported by the China Magnesium Association to be 157 000 t.

The China Aluminum Corp. (Chalco) replaced China National Nonferrous Metals Industry Corporation (CNNC) as the holder of the state's ownership in two magnesium producers with a total capacity of 12 000 t/y.

The Shanxi Wenxi Yinguang Magnesium Industry Group Co. Ltd. continued to expand in 1999 and now has a capacity of 20 000 t/y of pure and alloyed magnesium. Expansion has taken place through the purchase of a number of magnesium-producing plants in Shanxi Province and the company plans further acquisitions. (Additional information is available on the Internet at http://www.yinguang-mg.com.)

Norsk Hydro A/S announced in April 2000 that it would build a 5000-t/y magnesium alloy ingot foundry in China in Xi'an, approximately 800 km southwest of Beijing. Norsk Hydro intends to produce alloys from locally produced magnesium for this foundry and expects to complete construction by early 2001. Norsk Hydro's subsidiary, Norsk Hydro Magnesiumgesellschaft mbH of Germany, the leading producer of anodes in Europe, will construct a 400-t/y magnesium anode production plant in association with the foundry. The anodes would be used for water heaters and the plant would be expanded to 800 t/y in a second phase.

Republic of the Congo (Brazzaville)

Magnesium Alloy Corporation continued work on its Kouilou project in the Republic of the Congo (Brazzaville) during 1999. The project is based on two 2400-km^2 exploration permits in the Kouilou region. Previous exploration work for potash and oil has indicated the presence of potassium and magnesium salts, including carnallite, sylvanite and bischofite. The company negotiated a contract in

1998 with the Congolese government to evaluate and, if feasible, finance to production a magnesium solution mining and extraction plant.

In 1999, Salzgitter Anlagenbau GmBH completed a feasibility study for the company on a proposed 60 000-t/y plant in Pointe-Noire to solution mine the salt beds and produce magnesium metal. The proposed US$514 million plant is expected to have an operating cost of US$0.55/lb of magnesium with by-product chlorine, sodium chloride and potassium chloride potentially providing additional revenue.

Salzgitter, a company with expertise in solution mining of deposits similar to that held by Magnesium Alloy, offered to complete the project on a guaranteed turnkey basis. Magnesium extraction technology will be provided by the Russian National Aluminium and Magnesium Institute (VAMI) and the Ukrainian Titanium Institute.

During 1999, Warburg Dillon Read, a division of UBS AG, provided advice to the company in its search for a joint-venture partner.

In early 2000, at a mining seminar to attract new investment, the Congolese government announced that it planned to introduce a new mining code and reduce government involvement in the sector to improve the investment climate. (Additional information is available on the Internet at http://www.magnesiumalloy.ca.)

Australia

Australian Magnesium Corporation (AMC), based in Brisbane, conducted feasibility studies for a magnesium metal plant. As part of the feasibility study, the company produced its first batch of magnesium metal ingots in August 1999 at a 1500-t/y pilot plant located near Gladstone, Queensland.

AMC's feasibility study, conducted by Fluor Australia Proprietary Ltd., which has a 5% interest in the project, was released in early 2000. It proposed an A$1.13 billion project to construct and commission a metal plant with a capacity of 90 000 t/y of primary magnesium metal in Stanwell, Queensland. Magnesite feed would be obtained from Queensland Metals Corporation Limited's (QMC) existing mining/magnesia production operations at the Kunwara magnesite deposit approximately 50 km north of Stanwell.

The plant would produce magnesium alloys resulting in a total output of 97 000 t/y of metal product. Capital costs for the plant would be A$746 million with the remainder of the budget for commissioning and contingency costs. Operating costs were estimated to be US$0.64/lb. The company expects to make a final decision on the commercial plant and to complete debt financing of the project in 2000. Construction of the plant could begin in late 2000 with the production of metal starting in 2003 and full production in 2004. Should the plant operate as expected, the company envisages increasing capacity to 360 000 t/y as markets allow.

The proposed magnesium metal plant would use a low-temperature, chlorine-based process using an Alcan electrolytic cell. The process to produce magnesium metal from magnesite was developed over the last 10 years by the Commonwealth Scientific and Industrial Research Organization (CSIRO) for Queensland Metals. CSIRO provided expertise to the demonstration project and contributed A$7 million to the project. As a non-equity partner, it will receive a royalty from the company. Ford Motor Company invested US$30 million in the project in exchange for a 10-year agreement to purchase 45 000 t/y of magnesium metal. The test plant is now estimated to have cost A$125 million; including research expenditures, a total of over A$160 million was reported to have been spent on the project.

AMC is a subsidiary of Australian Magnesium Investments Pty Ltd. (AMI), which in turn is owned equally by QMC and Normandy Mining Ltd. Normandy Mining indicated in early 2000 that it was restructuring its operations and, subject to shareholder approval, would transfer ownership of AMI to QMC. Once completed, Normandy's share of QMC will increase to 62.5% and QMC's ownership in AMC will reach 95%. Once financing for the magnesium metal project is obtained, Normandy would distribute its holding in QMC to its shareholders.

AMI purchased an interest in Icelandic Magnesium Co. in 1998 and is studying construction of a second plant, which would be located in Iceland. (Additional information on AMC and AMI is available on the Internet at http://www.normandy.com.au or http://www.amc-magnesium.com.au.)

A number of other companies in Australia were interested in developing resources of magnesite or in reworking magnesium-rich mineral residues to produce magnesium metal, including: Samag Ltd.'s project in South Australia, Crest Magnesium NL's property in Tasmania, Golden Triangle Resources NL's project in Tasmania, Mt. Grace Resources NL's project in the Northern Territory, and Anaconda Nickel Limited's project in Western Australia.

Samag Ltd. (owned 80% by Pima Mining NL and 20% by Resource Finance Corporation Ltd.) continued work on a proposed metal plant based on magnesite deposits located near Leigh Creek in the Willouran Ranges region of South Australia. Samag proposes to construct an A$586 million (US$375 million), 52 500-t/y smelter using Dow technology. Cash operating costs are estimated at under US$0.60/lb.

During 1999, Hatch & Associates completed an A$1.5 million feasibility study for a metal plant. A proposal to mine the Mt. Hutton deposit in the Northern Flinders Ranges was also prepared for submission to government. In early 2000 the company chose a site for the proposed metal plant near Port Pirie in South Australia. With an agreement on technology from Dow and the hiring of former Dow personnel, this project has many of the prerequisites for bringing the plant to fruition. The project has been granted Major Project Status by the Commonwealth and State governments.

Samag held discussions with a number of companies seeking both equity participation and possibilities for future metal sales. The company intends to conduct further design studies and to obtain funding in late 2000, and to start construction thereafter. Metal would not be produced until mid-2003 at the earliest. (Additional information is available on the Internet at http://www.pima.com.au.)

Crest Magnesium NL, formerly Crest Resources Australia NL, continued work on a proposed 95 000-t/y magnesium metal plant, likely to be located near Bell Bay. The project is based on a magnesite property in the Arthur and Lyons rivers area in northwestern Tasmania. A 1998 study conducted by BHP Engineering Pty indicated that a project could be commercially viable with operating costs of US$0.65/lb using the company's rights to technology from the Ukrainian National Research and Design Titanium Institute and the Russian National Aluminium and Magnesium Institute (VAMI). The company's joint venture with Multiplex Construction Pty. Ltd. was terminated. Crest Magnesium subsequently indicated that it would scale back its project to 25 000 t/y. (Further information is available on the Internet at http://www.crestmagnesium.com.au.)

Golden Triangle Resources NL continued work on its Woodsreef magnesium project in New South Wales based on feed from asbestos tailings and a possible project with Hazelwood Power and HRL Technology Pty Ltd. for magnesium production from fly ash produced by Hazelwood. Golden Triangle arranged for the Joint Israeli-Russian Laboratory for Energy Research, in Beer Sheva, Israel, to conduct research for its magnesium project. A prefeasibility study of the Woodsreef project that indicated costs of A$681 million for an 80 000-t/y operation with operating costs of A$0.92/lb was completed. The company is carrying out second-stage feasibility work and has now decided on a site for its proposed magnesium refinery in the Latrobe Valley of Victoria, Australia, which was chosen because of the availability of energy. Golden Triangle envisages that a plant could be completed in 2004. The company had optioned and conducted work on a magnesium deposit at Mains Creek, but has dropped that option. (Further information can be obtained from Golden Triangle's web site at http://www.goldentriangle.com.au.)

Mt. Grace Resources NL continued work on its Northern Territory Batchelor magnesium project 85 km south of Darwin. After conducting tests in Melbourne using the Heggie Metallothermic Process to produce magnesium metal, the company obtained a licence to use the process. The Heggie process produces magnesium metal in a plasma arc furnace using metallic aluminum to reduce a charge of calcined magnesite. The company started preparation of a business plan for development of the project. Early in 2000 Mt. Grace announced an agreement with Multiplex Constructions Pty. Ltd. to seek funding for a 1000-t/y pilot plant to be constructed in Melbourne. The company envisages a plant with an initial 5000-t/y capacity by 2002 and a possible expansion thereafter. (Additional information is available on the Internet at http://www.mtgrace.com.)

In mid-1999, Anaconda Nickel announced that it was considering a large magnesium metal production plant (100 000 t/y). The project would be based on a magnesite deposit close to Murrin Murrin, a nickel-cobalt project near the Leonora/Laverton and Mount Margaret district. (Refer to the chapter on Nickel for details on this latter project.) (Additional information is available on the Internet at http://www.anaconda.com.au.)

OCCURRENCE

Magnesium is the eighth most abundant element, comprising over 2% of the earth's crust. It is the third most abundant element dissolved in seawater with a concentration averaging 0.14% by weight. Magnesium does not naturally occur in its native or metallic state, but is found in over 60 different minerals. The principal magnesium minerals include carbonate forms in dolomite and magnesite; as a silicate in olivine and brucite; as an oxide/silicate in serpentine; and as a chloride in seawater, natural brines and evaporites. In the past, magnesium metal has been produced from dolomite/magnesite, seawater, brines and brucite. Companies are also looking at producing magnesium from other magnesium-rich sources such as asbestos tailings and fly ash.

TECHNOLOGY

Magnesium metal is produced by a number of methods that can be classed into two general types of processes. These are: metallothermic, in which a reducing agent such as ferrosilicon is mixed with magnesium oxide and heated in a furnace under vacuum to produce magnesium metal vapour; and electrolytic, in which molten magnesium chloride salts are electrolyzed/reduced to produce liquid

metal. Larger plants generally use electrolytic methods, which account for over one half of the world's production capacity. Metallothermic methods require more labour and are more suitable for small batch operations; these have become more important with the increased production from China.

USE

Magnesium metal is best known for its light weight and high strength-to-weight ratio, making it suitable for a wide range of applications. When used as a structural material, magnesium is alloyed with other elements including aluminum, manganese, rare-earth metals, silver, thorium, zinc and zirconium. When alloyed with one or more of these elements, the resulting alloys can have unusually high strength-to-weight ratios. Magnesium-aluminum alloys are the most common and are principally used in die-casting applications.

Magnesium is a relatively "new" metal and alloy development for specific applications is not as advanced as for other more well-known metals. In addition, ways to avoid potential problems with corrosion are not as well developed for magnesium as for other metals such as iron and steel. As a result, some magnesium alloys have some limitations on their use due to the creep that can occur in higher temperature environments and the potential for corrosion in some circumstances. However, once work by various metal producers such as Noranda and Hydro Magnesium results in new higher-temperature, creep-resistant alloys, use in larger component automotive applications such as transmission housings, oil pans and engine blocks may increase.

The main application of magnesium is in its use as an alloying agent for aluminum. This use accounted for close to 43% of Western World shipments of primary magnesium in 1999. According to the IMA, Western World magnesium shipments for this application increased 3.5% to reach 159 800 t in 1999. Magnesium consumption for this end use is forecast to continue to increase by 2-3% annually.

The second largest use of magnesium is in high-pressure die-cast products, which can be used in structural applications such as in equipment cases or in instrument panel beams of automobiles. The IMA reported that shipments of magnesium for die-cast applications increased by 21% to a total of 133 400 t in 1999 from 110 100 t in 1998. During the next decade, high-pressure die casting is expected to be the fastest growing application.

Many automobile manufacturers are looking to die-cast magnesium parts to help reduce total vehicle weight while meeting the consumer demand for larger vehicles. The increased interest in magnesium metal in the automotive market is largely due to weight savings of more than 30% compared to aluminum, and a desire to increase fuel efficiency through weight reduction. Stricter fuel efficiency and emissions standards are encouraging many auto manufacturers to reduce their vehicles' weight. Increased consumer demand for sport utility vehicles and cars with added luxury items is also driving manufacturers to find ways to reduce automobile curb weight.

Magnesium has good vibration-dampening characteristics. Its lower heat of solidification, which increases die-casting production capacity by 25%, results in major process energy savings. Its characteristics also allow the casting of thinner and more complex shapes, which can replace a number of parts made with other materials, which in turn can also reduce the cost of assembly. In addition, magnesium dies are reported to have more than twice the life of aluminum dies. Furthermore, at a magnesium-to-aluminum price ratio of about 1.7:1.0 or less, many magnesium metal parts can be fabricated at a lower cost than those made from aluminum. In this regard, during 1999, the increased price of aluminum and the decreased price of magnesium have made the use of magnesium relatively more economical.

In addition to automotive applications, die-cast magnesium products are widely used in portable tools and sporting goods. In addition, the use of magnesium in electronic equipment, such as laptop computer housings and components, video cameras and cellular phones, has grown substantially. This trend is expected to continue. Magnesium's advantages for these applications are its good strength-to-weight ratio, heat dissipation, electromagnetic field containment, and radio frequency interference dissipation.

The third largest use of magnesium is as a desulphurizing agent in the ferrous industry where it is consumed in the production of steel and cast iron. Magnesium shipments in 1999 for desulphurization, as reported by the IMA, totaled 41 700 t, a decrease of over 15% from the 48 200 t shipped in 1998. Although this sector has grown at rates of up to 15% per year in the past, growth in the future, if any, will be slower due to advances in desulphurization methods that use lower quantities of magnesium in making low-sulphur steels.

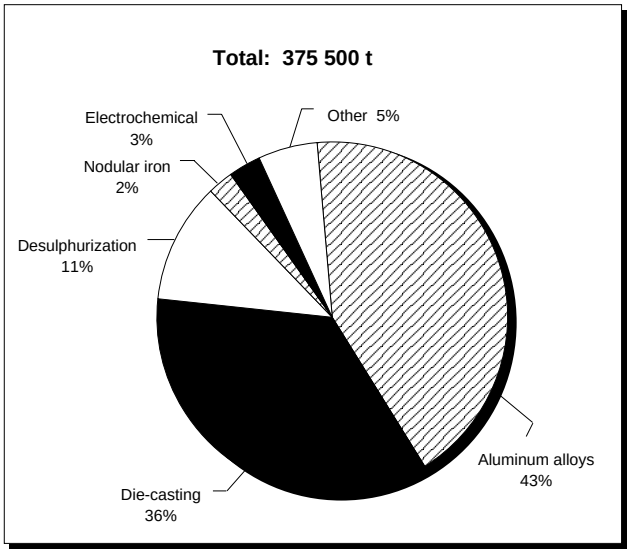
Magnesium is introduced into the melt during the production of nodular iron, which is used primarily for the production of ductile iron pipes and die-cast parts for use in automobiles and farm equipment. Shipments fell in 1999 to 8900 t, down almost 27% from 11 300 t in 1998. This application is expected to continue to face stiff competition as plastics increasingly penetrate the water pipe market.

Electrochemical applications account for about 3% of magnesium shipments for use in the manufacture of batteries and in anodes for the cathodic protection of gas pipelines and water heaters. Chemical applications, with about 1.4% of shipments, include the manufacture of pharmaceutical products, perfumes and pyrotechnics. Wrought products, accounting for about 1% of shipments, include extruded products except anodes, sheets and plates; gravity casting includes the production of complex or large parts by sand casting or casting with other materials. About 0.6% of magnesium shipments are used as a reducing agent in the production of titanium, beryllium, zirconium, hafnium and uranium.

CONSUMPTION

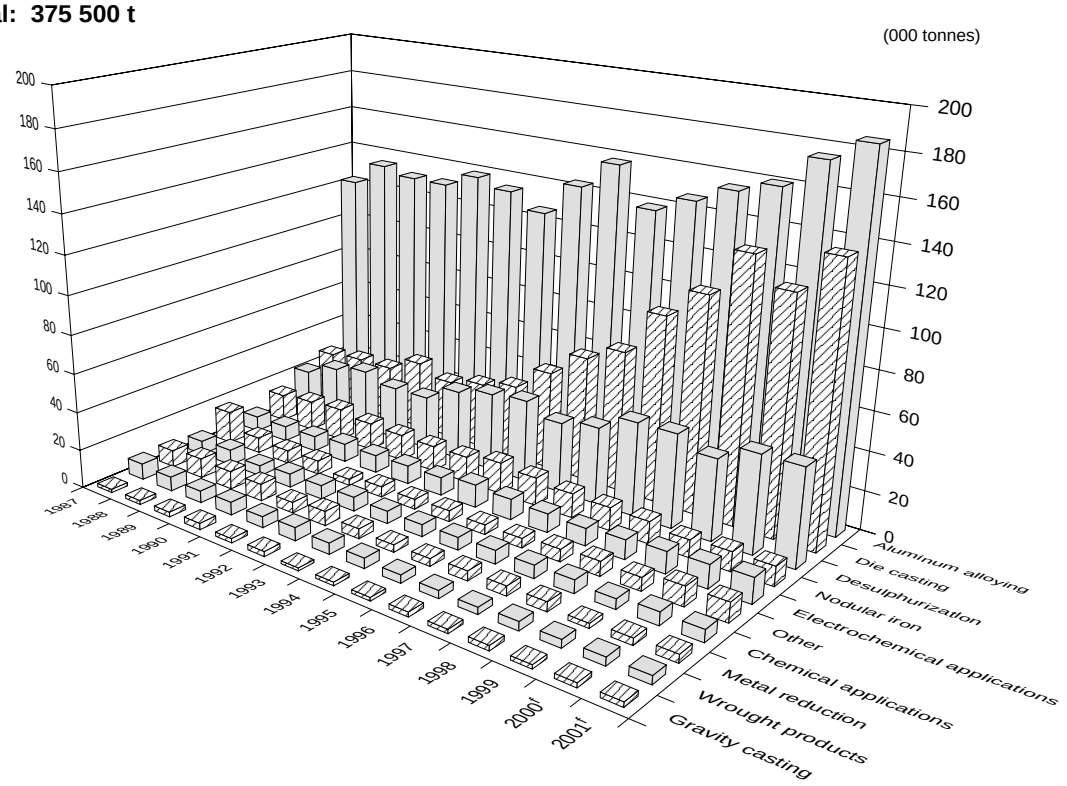
In Canada, the reported consumption of magnesium decreased from 34 000 t in 1997 to 32 600 t in 1998 due to small decreases in reported use in castings and alloy use. Previous growth in Canada's demand for magnesium has come from increased use in aluminum alloys and for castings and wrought products. (Global consumption figures for magnesium were not

Figure 5
Magnesium Shipments by Use, 1999



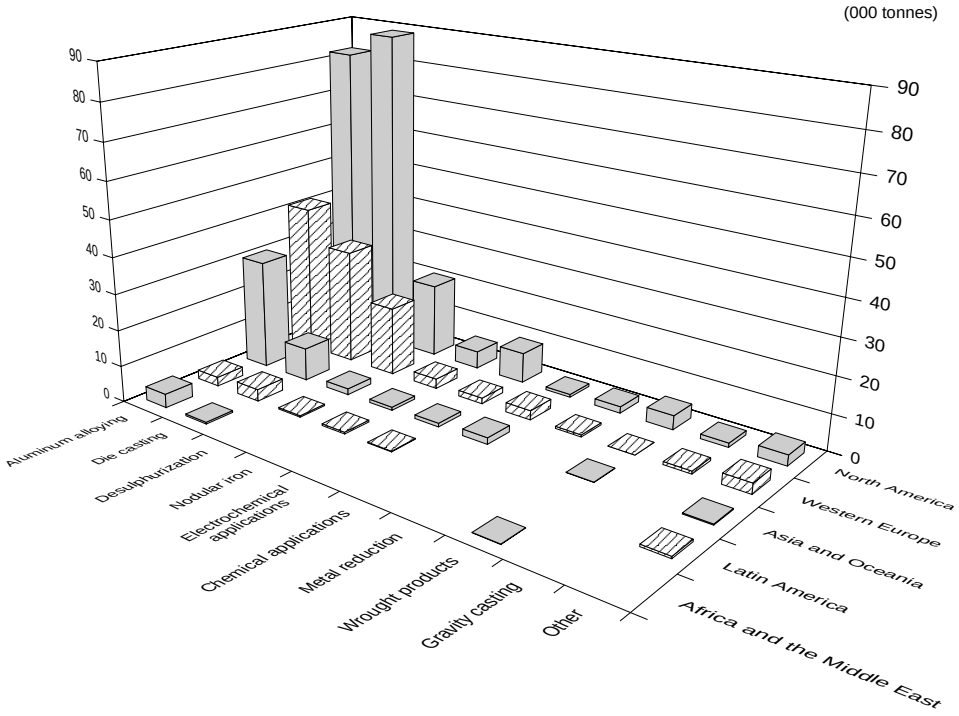
Source: International Magnesium Association.

Figure 6
Magnesium Shipments for Primary Producers, by Use, 1987-2001
1999 total: 375 500 t



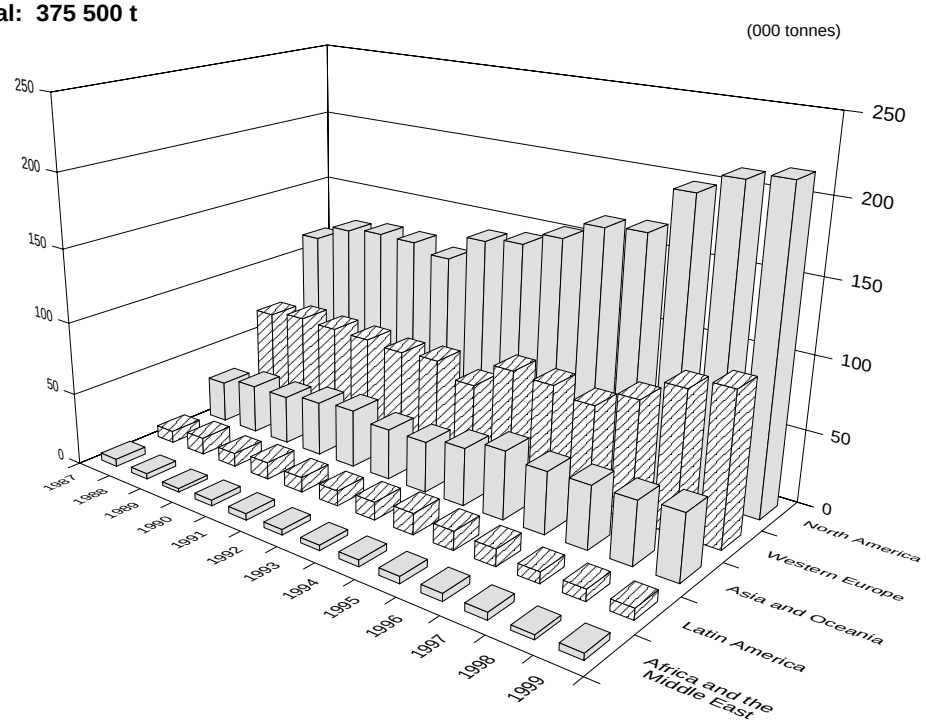
Sources: Natural Resources Canada; International Magnesium Association.
f Forecast.
Note: Die casting does not consume the total amount of material shipped. Shipment figures before 2000 may include recycled material. The die-casting estimate for 2000 does not include this recycled material.

Figure 7
Primary Magnesium Shipments by Category and Area, 1999
1999 total: 375 500 t



Source: International Magnesium Association.

Figure 8
Primary Magnesium Shipments by Area, 1987-99
1999 total: 375 500 t



Source: International Magnesium Association.

produced in 1999 by the International Consultative Group on Nonferrous Metals Statistics.)

The biggest potential for growth in the consumption of magnesium lies in the aluminum alloy and automotive markets sectors. However, growth will be dependent on prices and price stability as magnesium continues to face stiff competition from other materials, including aluminum, steel and plastics, in the all-important automotive parts sector. New applications and increased awareness of the advantages of magnesium in certain applications are growing, particularly in the North American automotive industry.

RECYCLING

The production of recycled magnesium from metallic scrap requires about 5% of the energy required to produce primary magnesium. The recycling of old magnesium scrap is expected to increase with the anticipated growth in the use of magnesium die-cast automobile parts. In addition, casting operations produce a high proportion of scrap in their operations that is recycled either on the site or at another location. Producers such as Norsk Hydro collect new magnesium scrap from their clients and recast the metal into a usable form and shape. This source of scrap is expected to increase with time as magnesium metal further penetrates the automotive and electronics markets and the vehicles and electrical equipment are scrapped. However, as technology and methods for recycling magnesium improve, it is likely that more recycling of producer and other clean new scrap will take place at casting operations. As figures are not collected on this run-around or new scrap, statistics on recycling magnesium will eventually show a decrease.

Major North American auto manufacturers, including Chrysler, Ford Motor Company and General Motors Corporation, use magnesium alloy parts containing recycled magnesium. The recovery and use of this recycled magnesium reduces the cost of die-cast components.

A number of new magnesium recycling facilities and expansions of existing facilities were announced during 1999 and early 2000. These include: Norsk Hydro's doubling of its subsidiary's facilities in Bottrop, Germany; Morimura Brothers Inc. and Onoda-Shoten Co.'s new 2000-t/y magnesium recycling facility in Japan; Nippon Kinzoku Co. Ltd.'s increase in capacity from 2200 t/y to 4800 t/y in Japan; and Magnesium Elektron's expansion of its facilities in the United Kingdom by 3000 t/y and construction of a 10 000-t/y plant in Germany. In addition, Xstrata AG studied the construction of a 25 000-t/y plant in the United States.

STOCKS AND PRICES

World markets made up for lost production from The Dow Chemical Company's Texas plant, which closed in 1998, with magnesium exports from China and from capacity creep and debottlenecking in existing plants. According to the IMA, 1999 year-end inventories of members totaled 45 900 t, 3.6% higher than the 44 300 t in inventory at the end of 1998. This inventory represents about 45 days of shipments from primary magnesium producers.

Magnesium is neither traded on the London Metal Exchange nor is it traded on the New York Mercantile Exchange (NYMEX). As a relatively "new" metal, the quantity of magnesium produced and used is lower compared to many other metals used for industrial and structural purposes. For example, primary magnesium production is about 2% of primary aluminum production. As a result, markets for the metal are young and not well developed. In addition, due to the limited market, magnesium prices are sensitive to supply and demand in end-use markets. As a result, there is little transparency in the price or information on stockpiles of product. Many producers have direct sales contracts with large consumers, often on a long-term basis. Magnesium producers' list prices can be taken as a general guide, but prices are dependent on many factors, including the quality, purity, location, form or shape, and the amount desired by an end user, as well as other factors. The prices for magnesium obtained from the various sources thus can give conflicting signals, as they did in 1999. Depending on location in the world, metal quality, and pricing differentials caused by duties and other factors, prices for primary magnesium for the year remained relatively steady, increased, or trended down.

Prices published by *Metals Week* for magnesium remained relatively steady throughout the year. The U.S. Spot Western Mean trended down from US$1.57/lb to US$1.51/lb, while the mean U.S. dealer import prices increased from US$1.30/lb early in the year to 1.40/lb in March, but ended the year at US$1.30/lb. The *Metal Bulletin*'s world free market price for minimum 99.8% magnesium metal started the year at US$1900-$2150/t and decreased to US$1800-$2250/t in February, but ended the year at US$2400-$2500/t. On the other hand, Norsk Hydro's European producer price for pure magnesium started the year at 2.94 euros/kg. In October, Norsk Hydro cut this price to 2.61 euros/kg (about US$1.30/lb) from the 2.76 euros/kg price posted in August 1999. Norsk Hydro's price for alloy was unchanged throughout the year from the 1997 price of 2.97 euros/kg, but decreased to 2.79 euros/kg in January 2000. Reported prices of Chinese magnesium started the year at approximately US$1900/t, decreasing to approximately US$1500/t at the end of 1999.

OUTLOOK

World primary magnesium production is expected to rise to over 500 000 t in 2000 from an estimated 476 000 t in 1999. With increasing use in die casting and intensity of use, particularly in automotive applications, magnesium consumption should continue to grow rapidly in the medium to long term. Magnesium production has been growing over the last 10 years at an estimated 4% per year, although this annual growth rate has accelerated to about 10% in the last five years.

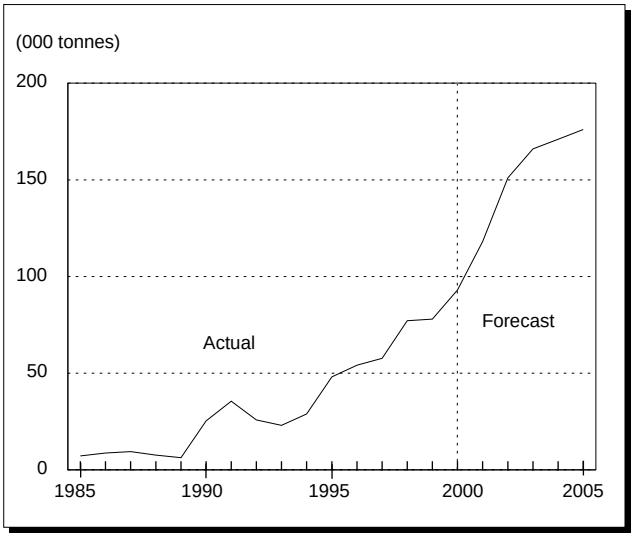
Canadian production of magnesium increased dramatically at the start of the decade with the opening of Norsk Hydro's 43 000-t/y Bécancour smelter in 1989. Canada's installed primary magnesium production capacity has since remained stable, but it is set to rise again with the addition of Magnola Metallurgy's 63 000-t/y plant at Danville, Quebec. Once completed, Canadian primary magnesium production capacity will rise to about 112 000 t/y and Canada will become the second largest magnesium producer in the world. In 1999, Canada was the third largest producer in the world after China and the United States.

The current consumption of magnesium in automotive applications is relatively low compared to other materials used in vehicles. Although some models contain larger quantities of magnesium, the average car has been estimated to contain approximately 3.5 kg, while the plastic content of the average car is estimated at over 110 kg. As a result, a relatively minor increase in magnesium used in automotive parts could result in a large increase in magnesium consumption.

Another major factor that will influence magnesium prices in the longer term will be the change in supply over the next decade as the result of expansions/re-openings of existing capacity, or the opening of new plants in China, Canada, Australia, Iceland and the Middle East in the near and medium-term future. The tonnages of metal that would be produced in these plants, should they become operational and remain economic, is impressive and would more than double current total global production. This potential increase in production may present both opportunities and challenges to existing producers while presenting new opportunities to large consumers.

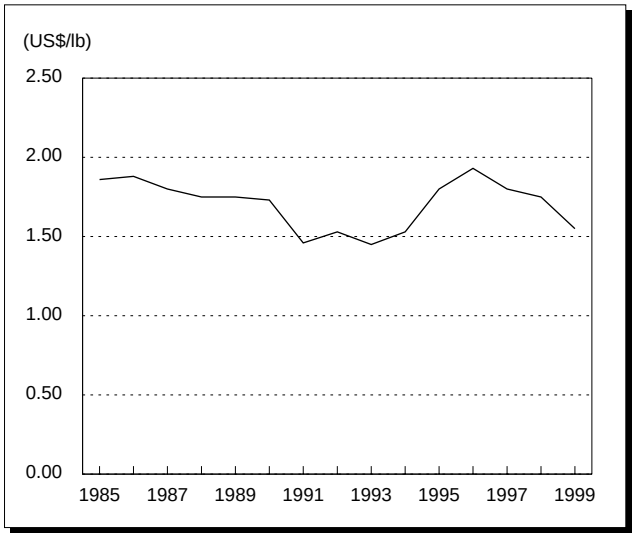
The prediction of prices for magnesium is complicated at this time due to the relatively rapid changes that are occurring in production levels, new uses for consumption, and the conflicting messages sent by price quotations in published prices. It is likely that prices will remain weak on a short-term basis until new uses increase demand.

Figure 9
Canadian Magnesium Production, 1985-2005



Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics.
Notes: Canadian production data are confidential. This estimate from the International Consultative Group on Nonferrous Metals Statistics includes secondary production.

Figure 10
Magnesium Prices, 1985-99
Average U.S. Spot Western Mean



Source: *Metals Week*.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of March 30, 2000. (3) Some differences are noted in some data from independent sources. Work is under way to determine the reasons for these differences. (4) This and other reviews, including previous editions, are available on the Internet at http://www.nrcan.gc.ca/mms/cmy/index_e.html.

NOTE TO READERS

The intent of this document is to provide general information and to elicit discussion. It is not intended as a reference, guide or suggestion to be used in trading, investment, or other commercial activities. The author and Natural Resources Canada make no warranty of any kind with respect to the content and accept no liability, either incidental, consequential, financial or otherwise, arising from the use of this document.

TARIFFS

Item No.	Description	Canada			United States[2]	EU[2]	Japan[1]
		MFN	GPT	USA	Canada	MFN	WTO
8104.11	Magnesium unwrought, containing by weight at least 99.8% of magnesium	2.5%	Free	Free	Free	5.3%	Free-3%
8104.19	Magnesium unwrought, other						
8104.19.10	Magnesium-rare earth, magnesium-didymium, magnesium-thorium, magnesium-zirconium and magnesium-thorium-neodymium-rare earth for use in the manufacture of magnesium castings	Free	Free	Free	Free	4%	Free-3%
8104.19.90	Other	2.5%	Free	Free	Free	4%	Free-3%
8104.20	Magnesium waste and scrap	Free	Free	Free	Free	Free	2.1%
8104.30	Magnesium raspings, turnings and granules, graded according to size; powders	2.5%	Free	Free	Free	4%	3%
8104.90	Other magnesium	2.5%	Free	Free	Free	4%	3%

Sources: Customs Tariff, effective January 2000, Canada Customs and Revenue Agency; Harmonized Tariff Schedule of the United States, 2000; Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of the European Union (39th Annual Edition: 1999); Custom Tariff Schedules of Japan, 1999.
[1] WTO rate is shown; lower tariff rates may apply circumstantially. [2] Contervail and anti-dumping duties may be applied depending on country of origin.

TABLE 1. CANADA, MAGNESIUM EXPORTS AND IMPORTS BY COMMODITY AND COUNTRY, 1998 AND 1999

Item No.		1998		1999p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS					
8104.11	Magnesium unwrought, containing by weight at least 99.8% magnesium				
	United States	2 324	12 392	3 916	19 940
	Germany	2 651	11 026	1 492	5 817
	Japan	2 294r	10 982r	874	4 125
	Austria	24	103	684	2 258
	United Kingdom	382	2 708	238	1 798
	France	264	1 193	319	1 784
	Netherlands	348	1 490	196	842
	Norway	544	2 095	112	300
	Switzerland	92	462	53	231
	Australia	1 482	6 111	43	189
	Other countries	367	1 674	8	45
	Total	10 772r	50 236r	7 935	37 329
8104.19	Magnesium unwrought, other				
	United States	29 746r	150 258r	28 841	145 503
	Netherlands	371	2 689	280	1 971
	Australia	588r	4 446r	276	1 823
	Italy	352	2 433	187	1 256
	United Kingdom	10	126	131	920
	Venezuela	218	918	510	560
	Germany	167	1 033	53	255
	Other countries	173	1 374	105	822
	Total	31 625r	163 277r	30 383	153 110
8104.20	Magnesium waste and scrap				
	Norway	–	–	3 361	6 907
	United States	2 689	6 960	2 152	4 665
	Other countries	–	–	99	326
	Total	2 689	6 960	5 612	11 898
8104.30	Magnesium raspings, turnings or granules, graded according to size and powders				
	United States	4 551	21 027r	5 236	19 261
	Ireland	135	1 054	212	1 649
	Other countries	236r	1 561r	235	1 603
	Total	4 922r	23 642r	5 683	22 513
8104.90	Magnesium and articles thereof, other				
	United States	80	545r	84	625
	United Kingdom	–	–	9	105
	Other countries	27	545	2	45
	Total	107	1 090r	95	775
	Total exports	50 115r	245 205r	49 708	225 625
IMPORTS					
8104.11	Magnesium unwrought, containing by weight at least 99.8% magnesium				
	China	3 679	13 690	3 437	10 048
	Israel	27	168	1 634	7 722
	Norway	165	853	1 151	6 359
	United States	2 035r	8 822r	786	3 923
	Other countries	1 109	4 710	1 656	6 423
	Total	7 015r	28 243r	8 664	34 475
8104.19	Magnesium unwrought, other				
	Norway	7	85	2 975	14 090
	China	3 092	11 213	2 954	9 435
	United States	3 329r	16 292r	1 505	7 193
	France	268	1 614	1 155	3 432
	Russia	4 028	18 258	767	3 358
	Other countries	130	1 453	182	1 740
	Total	10 854r	48 915r	9 538	39 248
8104.20	Magnesium waste and scrap				
	United States	13 372	43 205	16 663	66 753
	Other countries	209	302	184	200
	Total	13 581	43 507	16 847	66 953
8104.30	Magnesium raspings, turnings or granules, graded according to size and powders				
	United States	278	1 159	350	1 565
	United Kingdom	108	469	52	221
	Other countries	52	204	64	253
	Total	438	1 832	466	2 039
8104.90	Magnesium and articles thereof, other				
	United States	223	3 161	2 227	11 952
	Mexico	194	1 358	35	288
	Other countries	5	54	2	72
	Total	422	4 573	2 264	12 312
	Total imports	32 310	127 070	35 515	155 027

Source: Statistics Canada.
– Nil; p Preliminary; r Revised.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, CONSUMPTION[1] OF MAGNESIUM, 1992-98

	1992[a]	1993[a]	1994	1995[a]	1996	1997	1998[p]
				(tonnes)			
Castings and wrought products[2]	6 915	7 678	8 940	12 488	11 197	16 795	16 687
Aluminum alloys	9 203	10 174	12 389	12 323	14 022	14 793	13 417
Other uses[3]	2 005	2 162	2 234	2 329	2 357	2 438	2 459
Total	18 123	20 014	23 563	27 140	27 576	34 026	32 563

Source: Natural Resources Canada.
p Preliminary.
a Increase in number of companies being surveyed.
1 Available data as reported by consumers. **2** Die, permanent mould and sand castings, structural shapes, tubings, forgings, sheet and plate. **3** Cathodic protection, reducing agents, deoxidizers and other alloys.

TABLE 3. WORLD PRODUCTION OF MAGNESIUM, 1994-2000

Country	1994	1995	1996	1997	1998	1999[e]	2000[f]
				(000 tonnes)			
PRIMARY PRODUCTION							
China[2]	25.3[e]	93.5[e]	73.0[e]	92.0[e]	120.0[e]	157.0	165.0
United States	128.5	142.1	133.1	124.8	106.1	82.0	82.0
Canada[1]	28.9[r]	48.1	54.0[r]	57.7	77.1	80.0	100.0
Russia	35.4	37.5	35.0	39.5	40.0	38.0	45.0
Norway[3]	27.6	28.0	37.8	52.0[e]	49.0[e]	52.0	54.0
Israel	–	–	–	7.0[r]	25.0	25.0	30.0
France	12.3	14.5	14.0	13.8[r]	14.7	14.0	14.0
Brazil	8.8	9.7	9.0	9.0	9.0	10.0	10.0
Kazakstan	3.0	9.0	13.4[r]	9.0	9.0	9.0	15.0
Ukraine	12.0	13.0	12.9[r]	7.7[r]	5.0	5.0	5.0
Serbia & Montenegro	–	2.6	3.1	3.7	5.7	2.0	4.0
India	1.0	1.0	1.0	1.0	1.5	1.5	1.5
Japan	3.4	–	–	–	–	–	–
Total primary	286.2	399.0	386.3	417.2	462.1	475.5	525.5
SECONDARY PRODUCTION							
United States	62.1	65.1	70.2[r]	77.6[r]	76.4	78.0	85.0
Japan	19.0	11.8	21.2[r]	22.8[r]	20.0	22.0	25.0
Austria	0.1	0.1	–	–	–	–	–
Germany	–	–	–	–	–	–	2.0
Brazil	1.6	1.6	1.6	1.6	1.6	2.0	2.0
United Kingdom	0.5	0.5	0.5	0.5	0.5	1.0	1.0
Total secondary	83.3	79.1	93.5	102.5	98.5	103.0	115.0
Total production	369.5	478.1	479.8	519.7	560.6	578.5	640.5

Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics.
– Nil; **e** Estimated; **p** Preliminary; **r** Revised.
1 Estimate from the U.S. Geological Survey (includes secondary). **2** China Magnesium Association. **3** Robert E. Brown, personal communication data for 1997-99.

TABLE 4. WORLD CONSUMPTION OF MAGNESIUM, 1994-98

Country	1994	1995	1996	1997	1998
			(000 tonnes)		
PRIMARY PRODUCTION					
Argentina	0.4	0.4	0.4	0.4	. .
Australia[e]	4.0	4.0	4.0	4.0	. .
Austria	3.5	3.5	1.6	2.2	. .
Belgium/Luxembourg	4.4	4.0	1.3	5.1	. .
Brazil	10.5	10.0	10.0	10.0	. .
Cameroon	0.1	0.1	0.1	0.1	. .
Canada[r]	**23.6**	**27.1**	**27.6**	**34.0**	**32.6**
China	10.0	22.0	22.0	22.0	. .
Czech Republic	0.4	0.3	0.3	0.3	. .
Denmark	0.2	0.2	0.2	0.2	. .
Egypt[e]	1.0	1.2	1.0	1.0	. .
Former Yugoslavia	0.4	0.2	0.2	0.2	. .
France	16.1	17.0	18.7	20.1	. .
Germany	19.0	19.9	19.6	21.9	. .
Ghana	0.1	0.1	0.1	0.1	. .
Greece	0.1	0.1	0.1	0.1	. .
Hungary	0.2	0.2	0.2	0.2	. .
India	1.8	1.8	1.8	1.8	. .
Italy	4.7	5.4	6.2	9.3	. .
Japan	24.5	27.8	30.9	30.9	. .
Mexico	1.0	1.0	1.0	1.0	. .
Netherlands	1.0	1.2	1.2	1.2	. .
New Zealand[e]	0.4	0.4	0.4	0.4	. .
Norway[e]	6.0	6.0	6.0	6.0	. .
Poland[r]	0.7	0.7	0.8	0.8	0.8
Romania	0.4	0.3	0.3	2.3	. .
Russia	25.0	25.0	25.0	25.0	. .
South Africa	0.8	0.8	0.7	0.7	. .
South Korea	2.2	2.0	3.1	3.6	. .
Spain	1.7	1.5	1.5	2.3	. .
Sweden	2.2	2.2	1.7	1.6	. .
Switzerland	2.6	2.1	2.4	3.3	. .
Taiwan	1.5	3.0	1.7	2.9	. .
Turkey	0.6	1.5	0.5	0.5	. .
United States	112.0	109.0	102.0	101.0	. .
United Kingdom	6.0	6.0	5.2	4.9	. .
Venezuela	0.6	0.5	0.5	0.5	. .
Other	1.9	2.0	2.0	2.0	. .
Total primary	291.4	310.3	302.0	323.6	. .
SECONDARY MAGNESIUM					
Japan	14.3	17.1	21.6	21.6	. .
United States	62.1	65.0	70.9	70.9	. .
Total secondary	76.4	82.1	92.5	92.5	. .
Total world[r]	367.8	392.4	394.5	416.1	. .

Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics.
. . Consumption statistics not available; [e] Estimated; [r] Revised.