

# Magnesium Compounds

By Benjamin Petkof<sup>1</sup>

In 1977, the United States retained its place as a major world producer of magnesium compounds. Domestic output was based chiefly on the production of magnesia from brines. The quantity of magnesium compounds shipped and used declined from

that of 1976. Exports of magnesite and magnesia increased. Imports of processed magnesite declined from those of 1976.

Austria, Greece, the U.S.S.R., the People's Republic of China, and North Korea were major sources of magnesite.

**Table 1.—Salient magnesium compound statistics**

(Thousand short tons and thousand dollars)

	1973	1974	1975	1976	1977
<b>United States:</b>					
Caustic-calcined and specified magnesias: <sup>1</sup>					
Shipments by producers:					
Quantity -----	158	149	120	134	129
Value -----	26,929	27,916	17,207	28,277	29,574
Exports: Value <sup>2</sup> -----	4,196	5,088	4,538	5,422	6,336
Imports for consumption: Value <sup>2</sup> -----	734	692	502	808	566
Refractory magnesia:					
Sold and used by producers:					
Quantity -----	807	803	709	768	690
Value -----	69,904	77,044	103,839	106,522	94,799
Exports: Value -----	6,104	7,749	14,146	13,466	16,477
Imports: Value -----	13,469	16,463	20,588	13,976	12,332
Dead-burned dolomite:					
Sold and used by producers:					
Quantity -----	1,250	1,277	914	1,007	968
Value -----	23,441	32,078	31,193	37,079	37,992
World: Crude magnesite production: Quantity -----	10,162	11,097	<sup>r</sup> 10,614	<sup>r</sup> 9,847	9,753

<sup>r</sup> Revised.

<sup>1</sup>Excludes caustic-calcined magnesia used in production of refractory magnesia.

<sup>2</sup>Caustic-calcined magnesia only.

## DOMESTIC PRODUCTION

Natural brine solutions continued to be the primary source of domestically produced magnesium compounds. Natural magnesite and olivine were produced only at a few operations in the United States.

Barcroft Co., The Dow Chemical Co., Harbison-Walker Refractories Co., Kaiser Aluminum & Chemical Corp., and Merck & Co., Inc., produced magnesium hydroxide from seawater and well brines. Magnesium hydroxide was processed primarily into magnesia for conversion into basic refractories. The following firms produced refracto-

ry magnesia in 1977: Basic, Inc.; Basic Magnesia, Inc.; Corhart Refractories Co.; A. P. Green Refractories Co.; Harbison-Walker Refractories Co.; Kaiser Aluminum & Chemical Corp.; and Martin Marietta Chemicals.

Caustic-calcined magnesia was produced by Basic, Inc.; Basic Magnesia, Inc.; The Dow Chemical Co.; Kaiser Aluminum & Chemical Corp.; Martin Marietta Chemicals; and Velsicol Chemical Corp. Merck & Co., Inc., and Morton Chemical Co. produced specified magnesias. The Dow Chem-

ical Co., Mallinckrodt Chemical Works, and Philadelphia Quartz Co. produced magnesium sulfate. Magnesium carbonate was produced by Mallinckrodt Chemical Works, Merck & Co., Inc., Velsicol Chemical Corp., and Morton Chemical Co.

Magnesium chloride production was reported by the American Magnesium Co.;

The Dow Chemical Co., Kaiser Aluminum & Chemical Corp., and Mallinckrodt Chemical Works. Magnesium chloride was used primarily as cell-feed material for the production of magnesium metal. Domestic magnesium compounds producers by raw material source, location, and capacity follow:

Raw material source and producing company	Location	Capacity (short tons of MgO equivalent)
Magnesite: Basic, Inc	Gabbs, Nev	150,000
Lake brines:		
Great Salt Lake Minerals & Chemicals Corp	Ogden, Utah	100,000
Kaiser Aluminum & Chemical Corp	Wendover, Utah	50,000
Well brines:		
The Dow Chemical Co	Ludington, Mich	250,000
Martin Marietta Chemicals	Manistee, Mich	280,000
Morton Chemical Co	Manistee, Mich	5,000
Velsicol Chemical Corp	St. Louis, Mich	25,000
Seawater:		
Barcroft Co	Lewes, Del	5,000
Basic Magnesia, Inc	Port St. Joe, Fla	100,000
Corhart Refractories Co	Pascagoula, Miss	40,000
The Dow Chemical Co	Freeport, Tex	100,000
Harbison-Walker Refractories Co	Cape May, N.J	100,000
Kaiser Aluminum & Chemical Corp	Moss Landing, Calif	150,000
Merck & Co., Inc	South San Francisco, Calif	10,000
Western Magnesium Corp	Chula Vista, Calif	5,000
<b>Total</b>		<b>1,370,000</b>

## CONSUMPTION AND USES

Domestic demand for magnesium compounds was strong during 1977, but declines were noted in major consumption areas. The manufacture of refractory products was the major end use for magnesia. Refractory magnesia consumption declined 10% in quantity and 11% in value from that of 1976. Consumption of caustic-calcined and specified magnesias declined almost 4% in quantity but increased 5% in value; magnesium hydroxide use increased 53% in both quantity and value; magnesium sulfate increased 2% in quantity and 22% in value;

and the market for magnesium carbonate decreased 27% in quantity and 32% in value.

While the total quantity of caustic calcined and specified magnesias used for various end uses declined 4% from that of 1976, the quantity used for chemical processing, manufacturing, and metallurgy increased about 1%. The quantities used for agricultural, nutritional, and pharmaceutical applications and in construction materials declined about 7% and 8%, respectively.

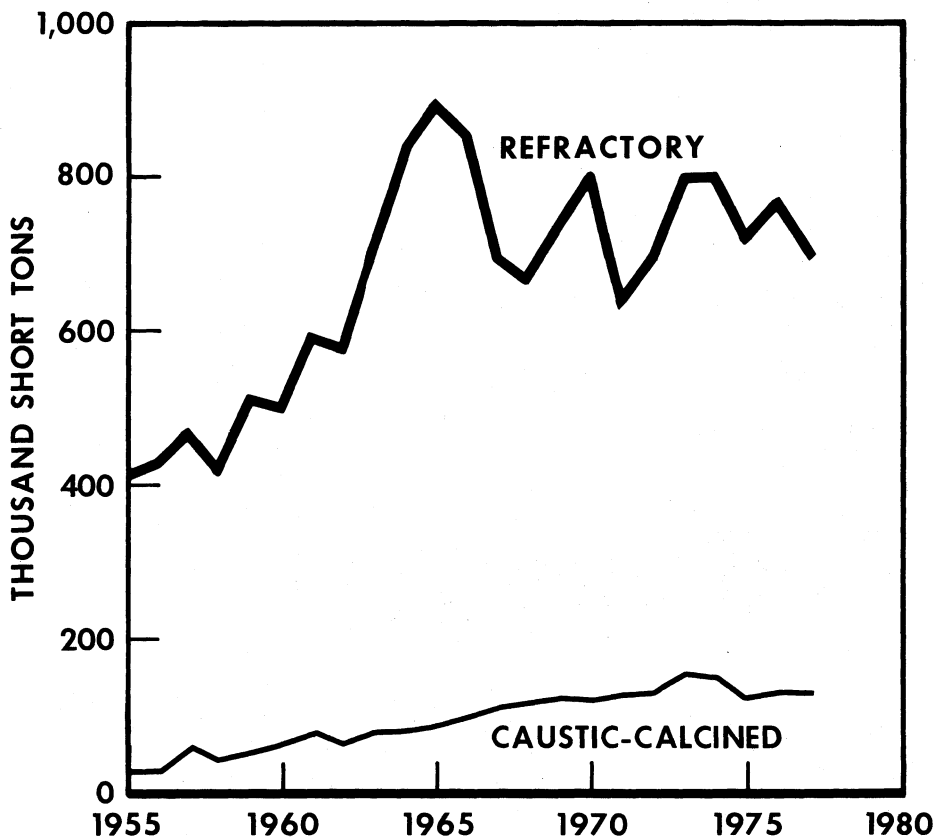


Figure 1.—Consumption and shipments of magnesia in the United States.

Table 2.—Magnesium compounds shipped and used in the United States

	1976		1977	
	Quantity (short tons)	Value (thou- sands)	Quantity (short tons)	Value (thou- sands)
Caustic-calcined <sup>1</sup> and specified (USP and technical) magnesia	134,458	\$23,277	128,846	\$29,574
Refractory magnesia	767,607	106,522	689,847	94,799
Magnesium hydroxide (100% Mg(OH) <sub>2</sub> ) <sup>1</sup>	61,059	7,784	93,314	11,879
Magnesium sulfate (anhydrous and hydrous)	55,993	9,835	57,113	11,953
Precipitated magnesium carbonate <sup>1</sup>	5,535	1,496	4,046	1,020

<sup>1</sup>Excludes material produced as an intermediate step in the manufacture of other magnesium compounds.

Table 3.—Domestic shipments of caustic-calcined and specified magnesias, by use

(Short tons)

Use	1976	1977
<b>Agriculture, nutrition, and pharmaceuticals:</b>		
Animal feed -----	29,859	26,518
Fertilizer -----	7,695	10,379
Medicinals and pharmaceuticals -----	2,548	689
Sugar and candy -----	W	3,886
Winemaking -----	W	--
<b>Total</b> -----	<b>44,393</b>	<b>41,472</b>
<b>Construction materials:</b>		
Insulation and wallboard -----	( <sup>1</sup> )	( <sup>1</sup> )
Oxychloride and oxysulfate cement -----	11,797	10,889
<b>Total</b> -----	<b>11,797</b>	<b>10,889</b>
<b>Chemical processing, manufacturing, and metallurgical:</b>		
Chemical -----	10,051	7,935
Electrical heating rods -----	11,629	11,650
Flux -----	W	W
Petroleum additive -----	10,955	11,912
Pulp and paper -----	12,997	15,933
Rayon -----	10,095	9,785
Rubber -----	12,108	11,677
Uranium processing -----	W	W
Water treatment -----	5,688	3,089
<b>Total</b> -----	<b>75,418</b>	<b>76,485</b>
Unspecified uses -----	2,850	W
<b>Grand total</b> -----	<b>134,458</b>	<b>128,846</b>

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

<sup>1</sup>Included with "Oxychloride and oxysulfate cement."

## PRICES

The Chemical Marketing Reporter quoted the following prices for magnesium compounds at yearend: Magnesia, natural, technical, heavy, 85% and 90% (bulk, carlot and truckload, f.o.b., Nevada), at \$120 and \$140 per short ton, respectively; magnesia, technical, neoprene-grade, light (bags, carlot and truckload, works), at \$346 per ton; magnesium carbonate, technical (bags, carlot and truckload, works, freight-equalized), at \$0.22 to \$0.23 per pound, and NF-grade

(bags, carlot, works, freight-equalized), at \$0.30 to \$0.31 per pound; magnesium hydroxide, NF, powder (drums, carlot and truck load, works, freight-equalized), at \$0.35 to \$0.36 per pound; magnesium chloride, hydrous, 99%, flake (bags, carlot, works), at \$140 per ton; magnesium sulfate, technical (bags, mixed carlot, 10,000-pound minimum works), at \$.091 per pound, and in bulk (same basis), \$.085 per pound.

## FOREIGN TRADE

Dead-burned magnesite and magnesia exports increased 7% in quantity and 22% in value from those of 1976. Most of the material was exported to Canada (72%), the Federal Republic of Germany (17%), and France (5%).

Magnesite exports including crude, caustic-calcined, lump or ground, increased 19% in quantity and 17% in value from those of 1976. Shipments to Canada and Venezuela accounted for 61% of the exports in this category.

Imports of lump or ground caustic-calcined magnesia decreased 29% in quantity and 30% in value from those of 1976. The bulk of the imports were from India (70%) and Australia (22%). Imports of dead-burned and grain magnesia and periclase containing a maximum of 4% lime decreased 16% in quantity and 12% in value from those of 1976. Almost the entire quantity imported originated in Ireland, Greece, and Japan. Imports in this category have declined since 1973. Imports of the same

material but containing over 4% lime increased 18% in quantity and 22% in value. Total imports of crude and processed magnesite declined 15%, from 96,229 tons in 1976 to 81,412 tons in 1977.

Imports of specified magnesium compounds and compounds not specifically provided for were valued at \$3,057,000, an increase of 35% over that of 1976.

Table 4.—U.S. exports of magnesite and magnesia, by country

Destination	Magnesite and magnesia, dead-burned				Magnesite, n.e.c., including crude caustic-calcined, lump or ground			
	1976		1977		1976		1977	
	Quantity (short tons)	Value (thou- sands)	Quantity (short tons)	Value (thou- sands)	Quantity (short tons)	Value (thou- sands)	Quantity (short tons)	Value (thou- sands)
Argentina	3,319	\$582	2,222	\$449	60	\$46	84	\$68
Australia			17	15	731	624	487	401
Austria	754	171	--	--	6	4	5	4
Belgium-Luxembourg			--	--	46	29	42	22
Brazil	93	94	87	80	112	81	37	32
Canada	42,043	7,038	55,370	10,564	3,036	1,292	2,962	1,525
Chile	294	54	90	21	52	25	22	21
Colombia	29	14	8	8	54	43	79	58
Denmark	22	7	--	--	--	--	44	14
Finland			--	--	78	62	26	24
France	983	177	3,680	744	343	282	223	143
Germany, Federal Republic of	17,085	3,675	12,976	3,795	667	465	522	399
India			--	--	--	--	47	46
Iran			--	--	--	--	116	71
Israel			--	--	22	15	44	36
Italy			--	--	395	225	235	156
Japan	33	24	--	--	85	155	184	186
Korea, Republic of			6	4	9	8	56	45
Mexico	3,544	461	177	27	635	94	56	43
Netherlands	15	4	15	6	261	185	307	427
Netherlands-Antilles	4	2	--	--	--	--	--	--
New Zealand	16	15	59	63	133	127	177	175
Peru			--	--	23	21	7	6
Philippines	144	49	4	1	44	36	39	36
Poland			--	--	--	--	276	57
Singapore			--	--	--	--	8	6
South Africa, Republic of	183	180	113	121	172	86	168	91
Spain	3	3	--	--	273	48	175	88
Sweden	22	23	33	35	357	380	225	247
Switzerland			--	--	--	--	7	5
Taiwan			16	13	41	25	180	101
United Kingdom	478	401	1,522	481	496	380	707	515
Venezuela			4	7	1,586	517	4,409	1,196
Yugoslavia			--	--	23	21	23	21
Other	2,309	492	90	43	381	146	81	71
<b>Total</b>	<b>71,373</b>	<b>13,466</b>	<b>76,489</b>	<b>16,477</b>	<b>10,121</b>	<b>5,422</b>	<b>12,040</b>	<b>6,336</b>

Table 5.—U.S. imports for consumption of crude and processed magnesite, by country

Country	1976		1977	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
<b>Lump or ground caustic-calcined magnesite:<sup>1</sup></b>				
Australia	1,501	\$228	1,286	\$189
Canada	7	2	—	—
Germany, Federal Republic of	—	—	2	(2)
India	5,427	406	4,073	294
Japan	175	20	103	41
Netherlands	203	27	103	17
Turkey	881	125	221	25
<b>Total</b>	<b>8,194</b>	<b>808</b>	<b>5,788</b>	<b>566</b>
<b>Dead-burned and grain magnesite and periclase:</b>				
<b>Not containing lime or not over 4% lime:</b>				
Austria	3,373	394	—	—
Canada	231	4	—	—
Czechoslovakia	—	—	44	7
Greece	33,094	5,638	18,327	3,009
Ireland	42,662	7,368	41,386	7,671
Japan	3,316	572	9,463	1,638
Netherlands	—	—	88	7
<b>Total</b>	<b>82,676</b>	<b>13,976</b>	<b>69,308</b>	<b>12,332</b>
<b>Containing over 4% lime:</b>				
Canada	410	47	253	28
Germany, Federal Republic of	1	2	—	—
Greece	—	—	5,918	622
Mexico	—	—	57	3
Netherlands	—	—	88	10
Spain	4,948	493	—	—
<b>Total</b>	<b>5,359</b>	<b>542</b>	<b>6,316</b>	<b>663</b>
<b>Total dead-burned and grain magnesite and periclase</b>	<b>88,035</b>	<b>14,518</b>	<b>75,624</b>	<b>12,995</b>

<sup>1</sup>In addition, crude magnesite was imported as follows: 1976—India, 5 short tons (\$456), Japan, 10 short tons (\$590), Mexico, 2 short tons (\$519), and the United Kingdom, 3 short tons (\$376); 1977—India, 13 short tons (\$636), and the Republic of South Africa, 236 short tons (\$10,596).

<sup>2</sup>Less than 1/2 unit.

Table 6.—U.S. imports for consumption of magnesium compounds

Year	Oxide or calcined magnesite		Magnesium carbonate <sup>1</sup> (precipitated)		Magnesium chloride (anhydrous)		Magnesium chloride (other)		Magnesium sulfate (epsom salts and kieserite)		Magnesium salts and compounds n.s.p. <sup>2</sup>	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
1975	360	\$148	63	\$97	103	\$42	50	\$9	32,991	\$1,070	2,999	\$427
1976	299	332	80	108	217	158	428	108	23,139	1,109	2,874	451
1977	420	536	67	117	53	26	90	14	36,100	1,388	5,115	976

<sup>1</sup>In addition, magnesium carbonate not precipitated, was imported in 1975—6 short tons (\$2,226); 1976—2 short tons (\$915); 1977—33 short tons (\$29,064).

<sup>2</sup>Not specifically provided for; includes magnesium silicofluoride or fluosilicate and calcined magnesium.

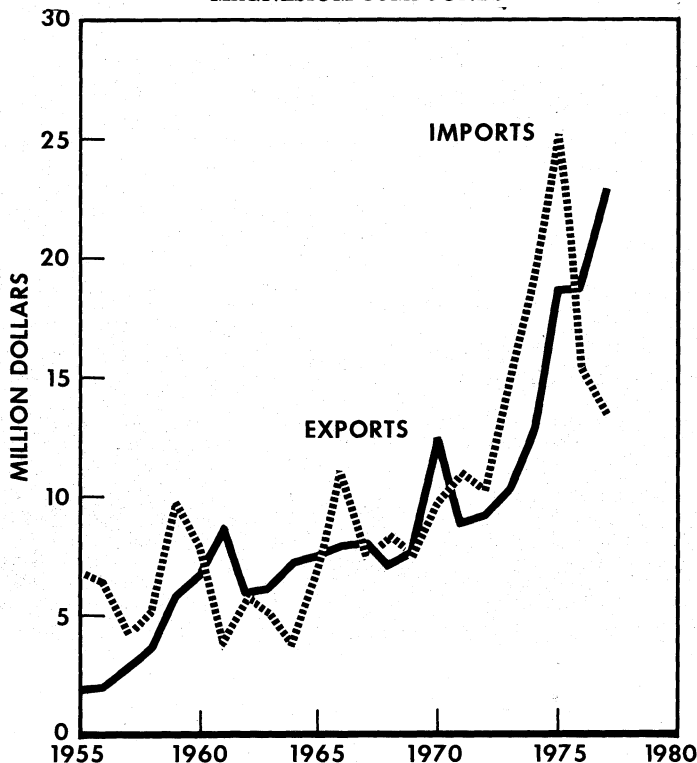


Figure 2.—Value of U.S. exports and imports of magnesia.

## WORLD REVIEW

**Greece.**— The Financial Mining-Industrial & Shipping Corp. (FIMISCO) of the Scalistiri Group delayed its plans to construct a \$50 million plant for the production of refractory-grade magnesia from seawater and dolomite. However, the engineering study for this project was completed in 1977. FIMISCO also canceled plans to develop magnesite mines on Lesbos Island.

FIMISCO began the production of Magflot, a briquetted, dead-burned magnesite produced from processed low-grade magnesite and wastes by proprietary technology, at the end of 1976 and continued production throughout 1977.

The Macedonian Magnesite Mining Industrial and Shipping Corp. (another Scalistiri Group Company) did not implement its authorization to construct a dead-burned magnesite plant similar to FIMISCO's operation. Construction of this plant was possible by the end of 1978.

The Scalistiri Group's total production of dead-burned magnesite and Magflot was 235,960 tons in 1977. The Scalistiri Group exported 150,000 tons of these refractory materials.

General Refractories' subsidiary, Magnomin General Mining Co., S.A., postponed its 1977 plans to install a new kiln at its Chalkidiki magnesite-processing facility. The firm began production of insulating board from low-grade, caustic-calcined magnesite, and wood for export to the Mediterranean and Middle East areas.

**India.**—On March 14, 1977, the Government temporarily relaxed its ban on calcined magnesite exports containing over 6.5% silica by approving the export of 9,072 tons during 1977. Dead-burned, raw and calcined magnesite containing over 9% silica remained exportable to all countries without any control.

**United Kingdom.**—Steetley Refractories

Ltd. opened a new section at its Hartlepool seawater magnesia plant at midyear. This section produced large grain, high density refractory magnesia using a new filtration

method that eliminated calcination and pelletization processes. Annual production capacity of the new plant section was 40,000 tons.

Table 7.—Magnesite: World production by country<sup>1</sup>

(Short tons)

Country	1975	1976	1977 <sup>P</sup>
North America:			
Mexico			
United States	43,567	25,558	<sup>e</sup> 28,000
	W	W	W
South America:			
Brazil <sup>2</sup>	<sup>r</sup> 191,477	215,917	<sup>e</sup> 220,000
Colombia <sup>e</sup>	<sup>r</sup> 865	<sup>r</sup> 900	<sup>e</sup> 900
Europe:			
Austria	1,395,358	1,021,334	1,105,662
Czechoslovakia	729,729	718,706	<sup>e</sup> 717,000
Greece	<sup>r</sup> 1,601,368	1,415,730	1,146,903
Poland	29,597	28,219	<sup>e</sup> 29,000
Spain	377,034	330,693	<sup>e</sup> 330,000
U.S.S.R. <sup>e</sup>	1,980,000	1,980,000	2,040,000
Yugoslavia	534,952	431,003	380,297
Africa:			
Kenya	<sup>r</sup> <sup>e</sup> 10	<sup>r</sup> <sup>e</sup> 10	3,941
Rhodesia, Southern <sup>e</sup>	22,000	22,000	22,000
South Africa, Republic of	67,464	69,289	54,255
Sudan <sup>e</sup>	110	110	--
Tanzania <sup>e</sup>	( <sup>3</sup> )	( <sup>3</sup> )	--
Asia:			
China, People's Republic of <sup>e</sup>	1,100,000	1,100,000	1,100,000
India	<sup>r</sup> 345,522	363,373	443,894
Iran <sup>4</sup>	17,600	5,500	<sup>e</sup> 11,000
Korea, North <sup>e</sup>	<sup>r</sup> 1,650,000	<sup>r</sup> 1,650,000	<sup>r</sup> 1,650,000
Pakistan	2,864	3,854	<sup>e</sup> 4,000
Turkey	505,816	447,539	<sup>e</sup> 450,000
Oceania:			
Australia	<sup>r</sup> 17,866	16,001	<sup>e</sup> 15,500
New Zealand	872	887	<sup>e</sup> 880
Total	<sup>r</sup> 10,614,071	9,846,623	9,753,232

<sup>e</sup>Estimate. <sup>P</sup>Preliminary. <sup>r</sup>Revised. W Withheld to avoid disclosing individual company confidential data.

<sup>1</sup>Figures represent crude salable magnesite. In addition to the countries listed, Bulgaria and Canada produce magnesite, but output is not reported and available information is inadequate to make reliable estimates of output levels.

<sup>2</sup>Series revised to reflect output of marketable concentrates. Production of crude ore for 1970-77 was as follows in short tons: 1970—238,542; 1971—256,885; 1972—304,979; 1973—303,392; 1974—393,151; 1975—484,428; 1976—457,081; 1977—463,000 (estimate). Production of marketable concentrates for 1970-74 was as follows in short tons: 1970—114,000 (estimate); 1971—121,000 (estimate); 1972—144,515; 1973—142,884; 1974—190,114.

<sup>3</sup>Revised to zero.

<sup>4</sup>Year beginning March 21 of that stated.

## TECHNOLOGY

Attrition grinding was investigated as a method to prepare foundry-sand-grade olivine from low-grade olivine sources such as such as dunite. The resulting concentrates met the Steel Founder's Society of America loss-of-ignition specifications. Studies indicated that the green and tensile strengths of the attrition-ground material were equivalent or superior to those of commercial materials. Metal casting molds from attrition-ground olivine produced better surface finishes that were attributed in part to increased grain sphericity.<sup>2</sup>

A report described the geology, reserves, and economic potential of an olivine deposit

on the San Carlos Apache Reservation in Arizona.<sup>3</sup>

A paper described the history and processes used to recover magnesium compounds from seawater for processing into magnesium oxide for refractory use.<sup>4</sup>

<sup>1</sup>Physical scientist, Division of Nonferrous Metals.

<sup>2</sup>Lamont, W. E., G. V. Sullivan, E. G. Davis, and S. D. Sanders. Olivine Foundry Sand From North Carolina Dunite by Differential Grinding. Preprint No. 77 H 369. Soc. of Min. Eng., AIME, Salt Lake City, Utah, 22 pp.

<sup>3</sup>Vuich, J. S., and R. T. Moore. Olivine Resources on San Carlos Apache Reservation. Arizona BuMines Fieldnotes No. 2, July 1977, pp. 1-10.

<sup>4</sup>Gilpin, W. C., and N. Heasman. Recovery of Magnesium Compounds From Sea Water. Chem. and Ind., No. 14, July 16, 1977, pp. 567-572.