

FELDSPAR AND NEPHELINE SYENITE

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Feldspar was used in commerce in the form of aluminosilicates that contain calcium, potassium, and sodium. Nepheline syenite is a light-colored, silica-deficient feldspathic rock made up mostly of sodium and potassium feldspars and nepheline; although not mined in the United States in 2001, it was imported from Canada for use in the glass and ceramic industries.

Feldspar

In glassmaking, alumina from feldspar improves product hardness, durability, and resistance to chemical corrosion. In ceramics, feldspar is used as a flux, melting at an early stage in the firing process and forming a glassy matrix that bonds together the other components of the system (Roskill Information Services Ltd., 1999, p. 165).

In 2001, shipments by U.S. producers of glass containers, a major end use of feldspar, were about 1% less than in 2000 (U.S. Census Bureau, 2002§¹). In the housing and remodeling markets, feldspar was used in glass fiber insulation, sanitaryware, and tile. Housing starts were about 1.6 million, which was about 2% more than in 2000 (National Association of Home Builders, 2002§).

Production.—U.S. production of marketable feldspar in 2001 was an estimated 800,000 metric tons (t) with a value of \$44.1 million (table 1). Feldspar was mined in seven States, which were, in descending order of output, North Carolina, California, Virginia, Georgia, Oklahoma, Idaho, and South Dakota. North Carolina accounted for about 43% of the total. Ten companies mined feldspar (table 3), nine of which operated beneficiation plants—four in North Carolina, three in California, and one in each of the remaining States listed above.

Domestic production data for feldspar were collected by the U.S. Geological Survey by means of a voluntary survey. Of the 12 known beneficiation plants, 5 responded by the data closeout date. The five operations represented about 48% of the year 2001 production shown in tables 1 and 2. Data for the remaining seven operations were estimated from prior-year production levels.

Imerys USA, Inc., purchased Kentucky-Tennessee Clay Co. from Hecla Mining Co. for \$62.5 million. The purchase included the K-T Feldspar Corp. operation in Spruce Pine, NC (Industrial Minerals, 2001).

Consumption.—Of the U.S. feldspar sold or used, about 70% went into the manufacture of glass, including glass containers and glass fiber. Pottery (including electrical insulators, sanitaryware, tableware, and tile) and other uses, such as fillers,

accounted for the remainder (table 4).

Foreign Trade.—U.S. exports (table 6) of 1,850 t to Italy in 2001 had a unit value of about \$463 per metric ton, compared with about \$105 per ton in 2000. This suggests that the 1,850 t may have been misclassified. U.S. imports (table 7) in 2001 and for the past several years primarily were from Mexico.

World Review.—Canada.—Avalon Ventures Ltd. of Toronto, Ontario, received results from a study for a modified concept for developing its Big Whopper pegmatite deposit, near Kenora, Ontario. The original concept was to separate petalite (lithium mineral) and two types of feldspar. The modified concept was to develop the deposit as a larger scale bulk producer of lithium-bearing feldspars for use in glass and ceramic applications; tantalum could remain an important byproduct of the operation. The company intended to proceed with a more detailed evaluation of this new development concept (Avalon Ventures Ltd., 2002§).

Southern Africa Minerals Corp., a base and precious metals junior exploration company, was to develop an anorthosite deposit 34 kilometers (km) southwest of Foleyet, Ontario, for the production of high-quality plagioclase feldspar. About 350 t of material was to be sent to a research laboratory for further processing, and about 320 t of the processed material was to be sent to a major glass company for a full-scale plant trial. If successful, the trial could lead to construction of a processing facility with initial capacity of 20,000 metric tons per year. Material also would be tested for suitability in other applications, such as a slag conditioner in ferrosilicon production, in rock wool production, as a filler in plastics, in ceramic tile, and other uses (North American Minerals News, 2001).

Europe.—The issue of glass container recycling has been prominent for 20 years in a number of countries. Effects of recycling include less space taken up in landfill sites, less energy used in melting virgin raw materials in glass furnaces, and reduced use of raw materials. Glass container recycling rates for Western European countries in 1999 ranged from 26% to 93%. Excess recycled green glass in the United Kingdom (U.K.) remained a problem; green glass from imported wine and beer bottles from recycling could not be mixed in production with the clear (flint) and brown glass that predominated in U.K. glass container manufacture. As in the United States, the glass industry was facing ongoing competition from metal and plastic food and beverage containers (Moore, 2001).

Mexico.—Production capacity of the tile industry was about 150 million square meters in 1999. Companies with the largest market share included Porcelanite SA de CV with 42%, Ceramica Vitromex SA de CV with 21%, and Lamosa Revestimientos SA de CV with 15%. Tile is preferred over carpets and wood in Mexico because of climatic conditions and

¹References that include a section twist (§) are found in the Internet References Cited section.

taste. Exports were 23% of production. Mexico supplied 14% of U.S. tile imports. Tile demand in the United States is largely in the Sun Belt States. For example, average per capita tile consumption in Arizona was 2.7 million square meters compared with a U.S. average of less than 0.5 million square meters. This compared with 5 million square meters used in Spain (Harris, 2001).

Current Research and Technology.—Alchemy Ventures Ltd. of Richmond, British Columbia, Canada, announced that test work was being conducted on recovery of byproduct potassium feldspar from its Helmer Bovill Kaolin Project in Idaho. The potassium feldspar recovery would follow clay recovery from raw ores. A 1-t sample of potassium feldspar concentrate was to be processed at bench scale and material sent to ceramics distributors for testing and blending work (Alchemy Ventures Ltd., 2001a§).

Test work also was being conducted on tailings of past mining operations from the Helmer Bovill site. Feldspar concentrates produced from processing these tailings were to be shipped to selected potential customers for evaluation. Material would be tested for use in ceramics, glazes, and as an extender/filler material. Results of this work were to be used to finish design requirements for Alchemy's pilot plant facility in Deary, ID (Alchemy Ventures Ltd., 2001b§).

Outlook.—One of the challenges facing the feldspar industry is the increased cost of energy, which includes propane, natural gas and fuel oil used for drying in the feldspar beneficiation process. Recycling of glass containers reduces the quantity of new feldspathic materials in glass manufacturing. Air quality and water quality standards may continue to become more stringent and more costly. The cost of transporting feldspathic materials is very often equal to the value of the material transported. Rail transport was still the dominant form of transportation; however, motor transport was gaining market share with faster delivery and reasonable cost (Rogers, 2002).

Plastic containers have made significant penetration against glass and other packaging types in the packaging market, especially in the food and beverage segments, according to The Freedomia Group, Cleveland, OH (Ceramic Industry, 2001). Some baby foods and beers have appeared in plastic containers. In the developed world, glass containers generally are perceived to have a high-quality or premium image relative to alternative packaging materials. By contrast, consumers in the developing world see glass as a lower quality and less-attractive packaging medium than aluminum cans.

A number of sanitaryware manufacturers also were facing challenges to stay profitable and had launched campaigns to consolidate and streamline their operations. One U.S. company, Kohler Co., however, reported increased sales in 2001; the company indicated that product innovation was a key factor in its market strategy. In addition, many U.S. companies were looking overseas for potential growth markets. American Standard Co., for example, reportedly, was having success in Europe and was optimistic about its opportunities in existing markets and in Eastern Europe (Grahl, 2001).

Nepheline Syenite

In glass and ceramics, nepheline syenite, like feldspar, provides alkalis that act as a flux to lower the melting

temperature of a glass or ceramic mixture, prompting faster melting and fuel savings. In glass, nepheline syenite also supplies alumina, which gives increased resistance to scratching and breaking, improved thermal endurance, and increased chemical durability.

Canada and Norway produced nepheline syenite for glass and ceramic use. In Ontario, Canada, Unimin Canada, Ltd., operated two plants at its Blue Mountain deposit, about 175 km northeast of Toronto. Output was about 650,000 t in 1999 (British Geological Survey, 2001, p. 302). End-use data were not available, but if usage patterns from Guillet (1994, p. 724) are projected to 2001, an estimated 70% of the output went into glass, especially container glass and glass fiber. About 15% was used in ceramic applications and 15% in pigments and fillers. Likewise, if data from Bolger (1995, p. 31) are projected, an estimated 60% of the output was shipped to U.S. markets, 20% to the Canadian market, and 20% to European countries.

In Norway, North Cape Minerals AS produced nepheline syenite from an underground mine on the Arctic island of Stjernoya; output was about 305,000 t in 1999 (British Geological Survey, 2001, p. 302). If data are projected from Bolger (1995, p. 38) to 2001, an estimated 70% of the output went to glass manufacturing, 28% to ceramics, and 2% to fillers.

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TABLE 1
SALIENT FELDSPAR AND NEPHELINE SYENITE STATISTICS 1/

		1997	1998	1999	2000	2001
United States:						
Feldspar:						
Produced e/ 2/	metric tons	900,000	820,000	875,000	790,000	800,000
Value e/	thousands	\$42,500	\$40,800	\$42,700	\$44,500	\$44,100
Exports 3/	metric tons	7,220	13,200	9,880	11,400	5,460
Value 3/	thousands	\$993	\$1,430	\$1,160	\$1,490	\$1,410
Imports for consumption 3/	metric tons	8,580	6,560	6,840	7,220	6,140
Value 3.	thousands	\$753	\$601	\$757	\$726	\$749
Nepheline syenite:						
Imports for consumption 3/	metric tons	346,000	320,000	311,000	356,000	336,000
Value 3/	thousands	\$23,900	\$24,100	\$23,200	\$24,800	\$24,100
Consumption, apparent (feldspar plus nepheline syenite) e/ 4/						1,140
World, production (feldspar)	do.	8,650 r/	9,220 r/	9,830 r/	9,420 r/	9,500 e/

e/ Estimated. r/ Revised.

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

2/ Includes hand-cobbed feldspar, flotation-concentrate feldspar, feldspar in feldspar-quartz mixtures, and aplite.

3/ Source: U.S. Census Bureau

4/ Production plus imports minus exports.

TABLE 2
ESTIMATED FELDSPAR PRODUCTION IN THE UNITED STATES 1/

(Thousand metric tons and thousand dollars)

Year	Flotation concentrate		Other 2/		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
2000	335	20,500	455	24,000	790	44,500
2001	328	19,700	472	24,500	800	44,100

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

2/ Includes hand-cobbed, feldspar-quartz mixtures (feldspar content), and aplite.

TABLE 3
U.S. PRODUCERS OF FELDSPAR AND FELDSPATHIC MATERIALS IN 2001

Company	Plant location	Product
APAC Arkansas Inc.	Muskogee, OK	Feldspar-quartz mixture.
The Feldspar Corp.	Monticello, GA	Potassium feldspar.
Do.	Spruce Pine, NC	Sodium-potassium feldspar; feldspar-quartz mixture.
PW Gillibrand Co.	Simi Valley, CA	Feldspar-quartz mixture.
Granite Rock Co.	Felton, CA	Do.
K-T Feldspar Corp.	Spruce Pine, NC	Sodium-potassium feldspar; feldspar-quartz mixture.
Oglebay Norton Specialty Minerals Inc.	Kings Mountain, NC	Feldspar-quartz mixture.
Pacer Corp.	Custer, SD	Potassium feldspar.
Tinton Enterprises Ltd.	Newell, SD (mine)	Do.
Unimin Corp.	Byron, CA	Feldspar-quartz mixture.
Do.	Emmett, ID	Do.
Do.	Spruce Pine, NC	Sodium-potassium feldspar.
U.S. Silica Co.	Montpelier, VA	Aplite.

TABLE 4
ESTIMATED FELDSPAR SOLD OR USED BY PRODUCERS IN
THE UNITED STATES, BY USE 1/ 2/

(Thousand metric tons and thousand dollars)

Use	2000		2001	
	Quantity	Value	Quantity	Value
Glass 3/	519	26,700	550	27,400
Pottery and miscellaneous	271	19,200	251	17,100
Total	790	46,000	800	44,500

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

2/ Includes hand-cobbed feldspar, flotation-concentrate feldspar, feldspar in feldspar-quartz mixtures, and aplite.

3/ Includes container glass, glass fiber, and other glass.

TABLE 5
PRICES FOR U.S. FELDSPAR, YEAREND 2001

(Dollars per metric ton)

	Price 1/
Ceramic grade:	
170 to 250 mesh, sodium	66- 83
200 mesh, potassium	138
Glass grade:	
30 mesh, sodium	44- 57
80 mesh, potassium	94- 99

1/ Bulk, ex-works, United States.

Source: Industrial Minerals, no. 411, December 2001, p. 82.

TABLE 6
U.S. EXPORTS OF FELDSPAR, BY COUNTRY 1/

Country	2000		2001	
	Quantity (metric tons)	Value	Quantity (metric tons)	Value
Canada	1,610	\$213,000	1,330	\$187,000
Costa Rica	1,500	210,000	1,240	166,000
Dominican Republic	312	60,000	163	21,800
India	378	40,000	--	--
Italy	5,720	598,000	1,850	857,000
Malaysia	82	27,000	280	69,600
Mexico	533	84,400	219	25,100
Nicaragua	817	113,000	122	16,700
Thailand	2	8,400	80	20,400
Venezuela	174	37,000	--	--
Other	261	99,000	174	50,000
Total	11,400	1,490,000	5,460	1,410,000

-- Zero.

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

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF FELDSPAR, BY COUNTRY 1/

Country	2000		2001	
	Quantity (metric tons)	Value 2/	Quantity (metric tons)	Value 2/
Mexico	7,080	\$636,000	5,980	\$601,000
Other	132	89,700	162	148,000
Total	7,220	726,000	6,140	749,000

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

Source: U.S. Census Bureau.

TABLE 8
FELDSPAR: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country 3/	1997	1998	1999	2000	2001 e/
Algeria e/	7,000	7,000	2,820	707 r/ 4/	--
Argentina	79,988 r/	42,468	62,926	61,000 e/	60,000
Australia (includes nepheline syenite) e/	68,800 r/	65,500 r/	49,600 r/	50,000 r/	50,000
Brazil	89,708 r/ 5/	59,200 r/ 6/	64,500 r/ 6/	61,000 r/ 6/	60,000 6/
Bulgaria	36,000	36,000	28,000	22,000	20,000
Burma e/ 7/	11,960 4/	12,000	12,000	12,000	12,000
Chile	3,808	1,460	1,346 r/	2,311 r/	2,350
Colombia e/	66,845 4/	55,000	55,000	55,000	55,000
Czech Republic	243,000	266,000	244,000	337,000	300,000
Ecuador	60,328	60,000 e/	33,142 r/	47,041 r/	45,000
Egypt	57,335	325,654	330,000 r/ e/	330,000 e/	300,000
Ethiopia	5,000 e/	5,000 e/	391	285	310
Finland e/	40,000	40,000	40,000	40,000	40,000
France (crude) e/	621,000 4/	706,000 r/	638,000 r/	642,000 r/	650,000
Germany e/	455,969 4/	460,000 r/	450,000 r/	450,000 r/	450,000
Greece e/	65,000	65,000	78,500 r/	96,000 r/	95,000
Guatemala	11,400 r/ e/	17,248 r/	17,072 r/	17,804 r/	17,000
India	95,455	104,509	105,000 e/	110,000 e/	110,000
Iran	125,000	185,709	239,779	240,000 e/	250,000
Italy e/	2,300,000	2,748,000 4/	2,700,000 r/	2,500,000 r/	2,600,000
Japan e/ 8/	55,000	50,000	52,000	52,000	50,000
Jordan	--	4,008	1,000	11,112	11,500
Kenya e/	120 r/	115 r/	115 r/	82 r/	100
Korea, Republic of	341,018	248,493	409,334 r/	330,417 r/	300,000
Macedonia	-- r/	8,137 r/	11,000 r/ e/	10,000 e/	10,000
Madagascar e/	--	6	4	4	4
Malaysia	9,779	31,369	26,940	27,000 e/	27,000
Mexico	155,760	197,866	262,241	334,439	350,000
Morocco	15,110	18,332 r/	1,112 r/	8,400 r/	8,000
Nigeria e/	1,000 4/	500	500	600	600
Norway (excludes nepheline syenite) e/	75,000	75,000	72,777 r/ 4/	75,000	73,000
Pakistan	25,169	31,191	29,235 r/	43,186 r/	44,000
Peru	2,502 r/	3,983 r/	1,594 r/	5,642 r/	5,600
Philippines	25,000 r/ e/	2,938 r/	16,909 r/	3,440 r/	4,000
Poland 9/	73,800	26,500	9,000 r/ e/	10,000 r/ e/	10,000
Portugal	121,380	120,000 e/	114,688 r/	119,837 r/	120,000
Romania	25,962	37,010	36,635	35,000 e/	35,000
Russia e/	45,000	40,000	45,000	45,000	45,000
Serbia and Montenegro	4,880	4,280	3,453	3,000 e/	3,000
South Africa	59,688	56,761	58,986	66,774	66,736 4/
Spain (includes pegmatite)	398,000	430,000	450,000 r/	460,000 r/	450,000

See footnotes at end of table.

TABLE 8--Continued
 FELDSPAR: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country 3/	1997	1998	1999	2000	2001 e/
Sri Lanka	25,700	25,274	26,012	28,638 r/	28,000
Sweden (salable, crude and ground)	50,000	45,000	45,000 e/	45,000 e/	45,000
Thailand	611,789	440,288	626,415	542,991	550,000
Turkey	1,011,542	1,089,483	1,369,655 r/	1,147,716 r/	1,200,000
United Kingdom (china stone) e/	8,000	3,278 r/ 4/	3,000 r/	2,000 r/	2,000
United States	900,000	820,000	875,000	790,000	800,000 4/
Uruguay	3,229	2,240 r/	1,556	1,600 e/	1,600
Uzbekistan	NA r/	NA r/	300 r/	4,300 r/	4,300
Venezuela	160,000	148,000	125,000 r/	139,000 r/	140,000
Zimbabwe	2,254	2,241	2,250 e/	2,200 r/ e/	2,250
Total	8,650,000 r/	9,220,000 r/	9,830,000 r/	9,420,000 r/	9,500,000

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

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

2/ Table includes data available through April 29, 2002.

3/ In addition to the countries listed, Namibia, Slovakia, and the United Arab Emirates may produce feldspar, but output is not officially reported; available general information is inadequate for the formulation of reliable estimates of output levels.

4/ Reported figure.

5/ Crude.

6/ Processed.

7/ Data are for fiscal years beginning April 1 of that stated.

8/ In addition, the following quantities of aplite ore were produced in metric tons: 1997-98--310,000 (estimated); 1999--330,000; 2000--330,000 (estimated); and 2001--310,000 (estimated).

9/ Poland reports two series. The first, as shown on this line, reflects strictly feldspar "mined" as such. The second includes "feldspar production," which is "mined" production and byproduct of granite quarrying and processing. Feldspar production is as follows in metric tons: 1997--108,100 (reported estimate); 1998--116,700 (reported estimate); 1999--105,300 (reported estimate); 2000--105,000 (estimated); and 2001--105,000 (estimated).