



2007 Minerals Yearbook

SILICA

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Four silica categories are covered in this report—industrial sand and gravel, quartz crystal (a form of crystalline silica), special silica stone products, and tripoli. Most of the stone covered in the special silica stone products section is novaculite. The section on tripoli includes tripoli and other fine-grained, porous silica materials, such as rottenstone, that have similar properties and end uses. Certain silica and silicate materials, such as diatomite and pumice, are covered in other chapters of the U.S. Geological Survey (USGS) Minerals Yearbook, volume I, Metals and Minerals. Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using unrounded data.

Industrial Sand and Gravel

Total industrial sand and gravel production increased to 30 million metric tons (Mt) in 2007 (table 1). Compared with that of 2006, industrial sand production increased by 3%, and gravel production increased by 40%, although industrial gravel was only 3.4% of the total.

Industrial sand and gravel, often called “silica,” “silica sand,” and “quartz sand,” includes sands and gravels with high silicon dioxide (SiO₂) content. Some examples of end uses of these sands and gravels are in glassmaking and for abrasive filtration, foundry, hydraulic fracturing (frac), and silicon metal applications. The specifications for each use vary, but silica resources for most uses are abundant. In almost all cases, silica mining uses open pit or dredging methods with standard mining equipment. Except for temporarily disturbing the immediate area while operations are active, sand and gravel mining usually has limited environmental impact.

The production increase for silica sand followed increased demand for many uses, which included abrasives, fiberglass (unground), fillers (ground and whole-grain), filtration, hydraulic fracturing, recreational, roofing granules, specialty glass, traction sand, and well packing and cementing sand. The demand for silica gravel was mostly used for filtration and nonmetallurgical flux.

Legislation and Government Programs.—One of the most important issues affecting the industrial minerals industry in recent years has been the potential effect of crystalline silica on human health. Central to the ongoing and often heated debate has been the understanding of the regulations and the implementation of the measurements and actions taken to mitigate exposure to crystalline silica and, most significantly, appreciation of its impact on the future of many industries (Industrial Minerals, 1998). The U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) has created a permissible exposure limit that stipulates the maximum amount of crystalline silica to which workers may be

safely exposed during an 8-hour work shift (29 CFR §§1926.55, 1910.1000). OSHA also presents guidelines and training for the proper handling of crystalline silica (U.S. Department of Labor, Occupational Safety and Health Administration, 2002).

Production.—Domestic production data for industrial sand and gravel were developed by the USGS from a voluntary survey of U.S. producers. The USGS canvassed 68 producers with 136 operations known to produce industrial sand and gravel. Of the 136 surveyed operations, 117 (86%) were active, and 19 were idle. The USGS received responses from 91 operations, and their combined production represented 84% of the U.S. total. Production for the 45 nonrespondents was estimated, primarily on the basis of previously reported information supplemented with worker-hours reports from the U.S. Department of Labor’s Mine Safety and Health Administration and information from State agencies.

The South (South Atlantic, East South Central, and West South Central divisions) led the Nation with 40% of the 30 Mt of industrial sand and gravel produced in the United States, followed by the Midwest (East North Central and West North Central divisions) with 37%, and the West (Pacific and Mountain divisions) with 11% (table 2).

The leading producing States were, in decreasing order, Illinois, Texas, Wisconsin, California, Oklahoma, North Carolina, Michigan, and Ohio (table 3). Their combined production represented 59% of the national total. States for which data have been withheld in table 3 are not included among the leading producers. Of the 34 States that produced silica in 2007, 19 had increased production, and 15 had decreased production, compared with those of 2006. Texas, North Carolina, and Wisconsin reported the largest increases, and Illinois, New Jersey, and Michigan reported the largest decreases.

Of the total industrial sand and gravel produced, 84% was produced by 50 operations, each with production of 200,000 metric tons per year (t/yr) or more (table 4). The 10 leading producers of industrial sand and gravel were, in descending order, Unimin Corp., U.S. Silica Co., Oglebay Norton Industrial Sands, Inc., Badger Mining Corp., Fairmount Minerals, Ltd., Little Six, Inc., Simplot Industries Inc., Manley Bros. of Indiana, Inc., B.V. Hedrick Gravel and Sand Co. Inc., and Nugent Sand Co. Inc. Their combined production represented 83% of the U.S. total.

Consumption.—Industrial sand and gravel production reported by producers to the USGS was material sold to their customers or used by the producing companies. Stockpiled material is not reported until consumed or sold. Of the 30 Mt of industrial sand and gravel sold or used, 33% was consumed as glassmaking sand, and 21%, as frac sand and sand for well packing and cementing (table 6). Foundry sand consumed 14%

of industrial sand and gravel consumption. Other important uses were building products (8%) and whole grain silica (5%).

Mineable deposits of industrial sand and gravel occur throughout the United States, and successful mining companies are located near markets that have traditionally been in the Eastern United States. In some cases, consuming industries are specifically located near a silica resource. The automotive industry was originally located in the Midwest near clay, coal, iron, and silica resources. Therefore, foundry sands have been widely produced in Illinois, Indiana, Michigan, Ohio, and other Midwestern States. In 2007, at least 77% of foundry sand was produced in the Midwest.

Producers of industrial sand and gravel were asked to provide statistics on the destination of silica produced at their operations. The producers were asked to list only the quantity of shipments (no value data were collected in this section of the questionnaire) and to which State or other location the material was shipped for consumption. The States that received the most industrial sand and gravel were Texas (12.5%), California (6.4%), Illinois (4.7%), Colorado (4.2%), Wisconsin (3.8%), and Ohio (3.6%). Producers reported sending at least 563,000 t of silica to Canada and 351,000 t to Mexico (table 7). Because some producers did not provide this information, their data were estimated or assigned to the "Destination unknown" category. In 2007, 17% of industrial sand and gravel shipped by producers was assigned to that category.

The share of silica sold for all types of glassmaking as a percentage of all silica sold was 33%, decreasing by about 3% compared with that of 2006. In 2007, sales to container glass manufacturers decreased slightly compared with those of 2006. On average, in the container glassmaking industry, silica accounts for 60% of raw materials used (Industrial Minerals, 2004). The amount of sand consumed for fiberglass production increased slightly compared with that of 2006.

In 2007, sales of sand for flat glass production decreased by 8% compared with those of 2006. In the Midwest, consumption for flat glass decreased by 20%, and in the South, consumption decreased slightly.

In 2007, 185,000 metric tons (t) of ground silica was used in ceramic production.

Silica also is used in plastics as an extender, filler, and reinforcer. Whole grain and ground silica are used in filler-type applications. In 2007, consumption of whole-grain filler was 2.5 Mt, and ground silica for filler was 376,000 t.

In table 6, industrial sand and gravel that would find its way into specialty silicas is most likely reported by the producers in the categories "Sand, abrasives, chemicals, ground and unground," "Gravel, silicon, ferrosilicon," and possibly "Glassmaking, specialty." In 2007, silica sales for chemical production were 812,000 t, which was a slight decrease compared with those of 2006. According to the USGS survey, reported sales of silica gravel for silicon and ferrosilicon production, filtration, and other uses, increased by 28% in 2007 compared with those of 2006. The main uses for silicon metal are in the manufacture of silanes and semiconductor-grade silicon and in the production of aluminum alloys.

Transportation.—Of all industrial sand and gravel produced, 51% was transported by truck from the plant to the site of first

sale or use, down from that of 2006; 31% was transported by rail, down slightly from that of 2006; and 18% by unspecified modes of transport.

Prices.—Compared with the average value of 2006, the average value, free on board plant, of U.S. industrial sand and gravel increased slightly to \$28.60 per metric ton in 2007 (table 6). The average unit values for industrial sand and industrial gravel were \$27.84 per ton and \$50.30 per ton, respectively. The average price for sand ranged from \$6.82 per ton for metallurgical flux to \$110.20 per ton for ground foundry sand. For gravel, prices ranged from \$18.66 per ton for other uses to \$124.25 per ton for silicon and ferrosilicon. Producer prices reported to the USGS for silica commonly ranged from several dollars per ton to hundreds of dollars per ton, and occasionally prices exceeded the \$1,000-per-ton level. Nationally, ground sand for foundry molding and core had the highest value (\$110.20 per ton), followed by silica for swimming pool filters (\$79.98 per ton), silica for water filtration (\$69.93 per ton), ground sand used as fillers for paint, putty, and rubber (\$60.19 per ton), ground sand for ceramics (\$59.51 per ton), ground sand for scouring cleansers (\$50.30 per ton), sand for hydraulic fracturing (\$49.56 per ton), and ground sand for fiberglass (\$48.68 per ton).

By geographic region, the average value of industrial sand and gravel was highest in the South (\$29.79 per ton), followed by the Midwest (\$28.88 per ton), the Northeast (\$27.81 per ton), and the West (\$23.65 per ton) (table 6). Prices can vary greatly for similar grades of silica at different locations in the United States, along with tighter supplies and higher production costs in certain regions of the country. For example, the average value of container glass sand varied from \$21.81 per ton in the Northeast to \$14.94 per ton in the Midwest.

Foreign Trade.—Exports of industrial sand and gravel in 2007 decreased by 21% compared with the amount exported in 2006, but the associated value increased by 32% (table 8). The large decrease in exports can be attributed mainly to decreased demand from Asian, European, and North American markets. Canada was the leading recipient of U.S. exports. The distribution of exports was as follows: 36% to Canada, 31% to Japan, 12% to Mexico, and the remainder to Africa and the Middle East, Europe, South America, and Oceania. The average unit value of exports increased to \$80 per ton in 2007 from \$48 per ton in 2006. In 2007, export unit values varied widely by region; exports of silica to Oceania averaged \$680 per ton, and exports to the rest of the world averaged \$239 per ton.

Imports for consumption of industrial sand and gravel declined to 511,000 t, which was a decrease of 40% compared with those of 2006 (table 9). Mexico supplied 57% of the silica imports, which averaged \$13 per ton; this price included insurance and freight costs to the U.S. port. The total value of imports was \$24 million, with an average unit value of \$47 per ton. Higher priced imports came from Australia, Chile, China, Germany, and Japan.

World Industry Structure.—Based on information provided mainly by foreign governments, world production of industrial sand and gravel was estimated to be 126 Mt (table 11). The United States was the leading producer followed, in descending order, by Italy, Germany, Austria, the United Kingdom,

Australia, France, and Spain. Most countries in the world had some production and consumption of industrial sand and gravel, which are essential to the glass and foundry industries. Because of the great variation in reporting standards, however, obtaining reliable information was difficult. In addition to the countries listed, many other countries were thought to have had some type of silica production and consumption.

Outlook.—U.S. consumption of industrial sand and gravel in 2008 was expected to be 29 to 30 Mt. All forecasts are based on previous performances for this mineral commodity within various end uses, contingency factors considered relevant to the future of the commodity, and forecasts made by analysts and producers in the various markets.

Sales of glass sand can be expected to vary from market to market. Growth has been noted in some segments, such as flat and specialty glasses, container glass, and frac sand. Total demand for all glass sand end uses is expected to remain static or possibly exhibit slow growth through 2008. Demand for industrial sand and gravel will also be constrained by the producers' rising energy costs for both production and transportation of product.

The demand for foundry sand is dependent mainly on automobile and light truck production. Another important factor for the future consumption of virgin foundry sand is the recycling of used foundry sand. The level of recycling is thought to be increasing. Other materials or minerals compete with silica as foundry sand, but these other "sands" usually suffer from a severe price disadvantage. Based on these factors, consumption of silica foundry sand in 2008 is expected to be 4 Mt, and consumption is expected to be 4.0 to 4.5 Mt.

Frac sand sales increased in 2007 compared with those of 2006. Based on this trend, demand for frac sand is expected to increase during 2008 to 6 Mt, in the range of 6 to 6.5 Mt.

The United States is the leading producer and a major consumer of silica sand and is self-sufficient in this mined commodity. Most of it is produced at premier deposits in the Midwest and near major markets in the Eastern United States. A significant amount of silica sand is also produced in the West and Southwest, mostly in California and Texas, respectively. Domestic production is expected to continue to meet 97% or 98% of demand well beyond 2008. Imports mostly from Canada and Mexico and higher valued material from China are expected to remain minor.

Because the unit price of silica sand is relatively low, except for a few end uses that require a high degree of processing, the location of a silica sand deposit in relation to the market is an important factor that may work for or against a sand producer. Consequently, a significant number of relatively small operations supply local markets with a limited number of products.

Several factors could affect supply and demand relations for silica sand. Further increases in the development of substitute materials for glass and cast metals could reduce demand for foundry and glass sand. These substitutes, which are mainly ceramics and polymers, would likely increase the demand for ground silica, which is used as a filler in plastics; glass fibers, which are used in reinforced plastics; and silica (chemical, ground, or whole-grain), which is used to manufacture ceramics.

Increased efforts to reduce waste and to increase recycling also could lower the demand for mined glass sand. Recycling of glass cullet is increasing in most industrialized nations and recycling accounts for approximately 25% to 70% of the raw material needed for the glass container industry in many countries. It has been estimated that for every 10% of recycled glass cullet used in the melting process for glass container manufacture, energy use will fall approximately 2.5%. During the past 20 years, a 25% to 40% reduction in glass container weight has taken place in many nations, including the United States (Industrial Minerals, 2004). Although developments could cause the demand for silica sand to decrease, the total value of production could increase because of the increased unit value of the more specialized sands.

Health concerns about the use of silica as an abrasive and stricter legislative and regulatory measures concerning crystalline silica exposure could reduce the demand in many silica markets. The use of silica sand in the abrasive blast industry was being evaluated as a health hazard as marketers of competing materials, which include garnet, olivine, and slags, encouraged the use of their "safer" abrasive media. Additionally, abrasive-grade bauxite, which is the feedstock for brown fused alumina, is finding increasing use in abrasives and proppants; in the latter application, bauxite is used to hold fractures open in oil wells, as is silica sand (Industrial Minerals, 2002).

Quartz Crystal

Electronic-grade quartz crystal, also known as cultured quartz crystal, is single-crystal silica with properties that make it uniquely useful in accurate filters, frequency controls, and timers used in electronic circuits. These devices are used for a variety of electronic applications in aerospace hardware, commercial and military navigational instruments, communications equipment, computers, and consumer goods (for example, clocks, games, television receivers, and toys). Such uses generate practically all the demand for electronic-grade quartz crystal. A lesser amount of optical-grade quartz crystal is used for lenses and windows in specialized devices, which include some lasers.

Natural quartz crystal was used in most electronic and optical applications until 1971 when it was surpassed by cultured quartz crystal. Cultured quartz is not a mined mineral commodity. Rather, it is synthetically produced from natural feedstock quartz, termed lascas, which is mined. Mining of lascas in the United States ceased in 1997, owing to competition from less expensive imported lascas predominantly from mines in Brazil and Madagascar.

Additionally, it has been estimated that approximately 10 billion quartz crystals and oscillators were manufactured and installed worldwide in all types of electronic devices, from automobiles to cellular telephones in 2006.

The use of natural quartz crystal for carvings and other gemstone applications has continued; more information can be found in the "Gemstones" chapter of the USGS Minerals Yearbook, volume I, Metals and Minerals.

Legislation and Government Programs.—The strategic value of quartz crystal was demonstrated during World War II when

it gained widespread use as an essential component of military communication systems. After the war, natural electronic-grade quartz crystal was officially designated as a strategic and critical material for stockpiling by the Federal Government. Cultured quartz crystal, which eventually supplanted natural crystal in nearly all applications, was not commercially available when acquisition of natural quartz crystal for a national stockpile began.

As of December 31, 2007, the National Defense Stockpile (NDS) contained 7,134 kilograms (kg) of natural quartz crystal. The stockpile has 11 weight classes for natural quartz crystal that range from 0.2 kg to more than 10 kg. The stockpiled crystals, however, are primarily in the larger weight classes. The larger pieces are suitable as seed crystals, which are very thin crystals cut to exact dimensions, to produce cultured quartz crystal. In addition, many of the stockpiled crystals could be of interest to the specimen and gemstone industry. Little, if any, of the stockpiled material is likely to be used in the same applications as cultured quartz crystal.

No natural quartz crystal was sold from the NDS in 2007, and the Federal Government does not intend to dispose of or sell any of the remaining material. Previously, only individual crystals in the NDS inventory that weighed 10 kg or more and could be used as seed material were sold. Brazil traditionally has been the source of such large natural crystals, but changes in mining operations have reduced output.

Quartz crystal is also affected by the regulation of crystalline silica as discussed in the “Legislation and Government Programs” portion of the “Industrial Sand and Gravel” section of this chapter.

Production.—The USGS collects production data for quartz crystal through a survey of the domestic industry. In 2007, no domestic companies reported the production of cultured quartz crystal. In the past several years, cultured quartz crystal was being produced predominantly overseas, primarily in Asia.

Consumption.—In 2007, the USGS collected domestic consumption data for quartz crystal through a survey of 23 U.S. operations that fabricate quartz crystal devices in 9 States. Of the 23 operations, 12 responded to the survey. Consumption for nonrespondents was estimated based on reports from previous years.

Prices.—The average value of as-grown cultured quartz was estimated to be \$120 per kilogram in 2007. Lumbered quartz, which is as-grown cultured quartz that has been processed by sawing and grinding, was estimated to be \$297 per kilogram in 2007.

Foreign Trade.—The U.S. Department of Commerce (DOC), which is the major Government source of U.S. trade data, does not provide specific import or export statistics on lascar. The DOC collects export and import statistics on electronic and optical-grade quartz crystal; however, the quartz crystal export and import quantities and values reported in previous years included zirconia inadvertently reported to be quartz crystal not including mounted piezoelectric crystals.

World Review.—Cultured quartz crystal production is concentrated in China, Japan, and Russia; several companies produce crystal in each country. Other producing countries are Belgium, Brazil, Bulgaria, France, Germany, South Africa,

and the United Kingdom. Details concerning quartz operations in China, the Eastern European countries, and most nations of the Commonwealth of Independent States are unavailable. Operations in Russia, however, have significant capacity to produce synthetic quartz.

Outlook.—Growth of the consumer electronics market (for example, automobiles, cellular telephones, electronic games, and personal computers), particularly in the United States, will continue to provide consumer outlets for domestic production of quartz crystal devices. The increasing global electronics market may require additional production capacity worldwide. Quartz technology could face competition in the near future with the advent of more cost effective microelectromechanical systems (MEMS). MEMS technology was first developed in 1965 and consists of silicon on insulated wafers. MEMS technology is physically compatible with existing quartz oscillator products and have better long-term stability performance characteristics for use in automotive, consumer, computational products, and wireless applications (Partridge, 2006).

Special Silica Stone Products

Silica stone (another type of crystalline silica) products are materials for abrasive tools, such as deburring media, grinding pebbles, grindstones, hones, oilstones, stone files, tube-mill liners, and whetstones. These products are manufactured from novaculite, quartzite, and other microcrystalline quartz rock. This chapter, however, excludes products that are fabricated from such materials by artificial bonding of the abrasive grains (information on other manufactured and natural abrasives may be found in other USGS Minerals Yearbook, volume I, Metals and Minerals chapters).

Special silica stone is also affected by the regulation of crystalline silica as discussed in the “Legislation and Government Programs” part of the “Industrial Sand and Gravel” section of this chapter.

Production.—In response to a USGS production survey, three of six domestic firms, representing 69% of crude production, responded during 2007. Data for the remaining producers were estimated. Arkansas accounted for most of the value and quantity of production reported. Plants in Arkansas manufactured files, deburring-tumbling media, oilstones, and whetstones (table 10).

The industry has produced and marketed four main grades of Arkansas whetstone in recent years. The grades range from the high-quality black hard Arkansas stone down to Washita stone. In general, the black hard Arkansas stone has a porosity of 0.07% and a waxy luster, and Washita stone has a porosity of 16% and resembles unglazed porcelain.

Consumption.—The domestic consumption of special silica stone products is by a combination of craft, household, industrial, and leisure uses. The leading household use is for sharpening of knives and other cutlery, lawn and garden tools, scissors, and shears. Major industrial uses include deburring of metal and plastic castings, polishing of metal surfaces, and sharpening and honing of cutting surfaces. The major recreational use is in sharpening of arrowheads, fishhooks, spear points, and sports knives. The leading craft application

is sharpening tools for engraving, jewelry making, and woodcarving. Silica stone files are also used in the manufacture, modification, and repair of firearms.

Prices.—The average value of crude material suitable for cutting into finished products was \$4,416 per ton. The average value of stone products made from crude material was \$1.62 per kilogram (table 1).

Foreign Trade.—In 2007, silica stone product exports had a value of \$8.6 million, down slightly from that of 2006. These exports were categorized as “hand sharpening or polishing stones” by the DOC. This category accounted for most, if not all, of the silica stone products exported in 2006.

In 2007, the value of imported silica stone products was \$9 million; this was an increase of 12% compared with that of 2006. These imports were hand sharpening or polishing stones, which accounted for most or all the imported silica stone products in 2007. A portion of the finished products that were imported may have been made from crude novaculite produced in the United States and exported for processing.

Outlook.—Consumption patterns for special silica stone are not expected to change significantly during the next several years. Most of the existing markets are well defined, and the probability of new uses is low.

Tripoli

Tripoli, broadly defined, includes extremely fine grained crystalline silica in various stages of aggregation. Grain sizes usually range from 1 to 10 micrometers (μm), but particles as small as 0.1 to 0.2 μm are common. Commercial tripoli contains 98% to 99% silica and minor amounts of alumina (as clay) and iron oxide. Tripoli may be white or some shade of brown, red, or yellow depending upon the percentage of iron oxide.

Tripoli also is affected by the regulation of crystalline silica as discussed in the “Legislation and Government Programs” part of the “Industrial Sand and Gravel” section of this chapter.

Production.—In 2007, five U.S. firms were known to produce and process tripoli. American Tripoli Co. produced crude material in Ottawa County, OK, and finished material in Newton County, MO. Keystone Filler and Manufacturing Co. in Northumberland County, PA, processed rottenstone, which is decomposed fine-grained siliceous shale purchased from local suppliers. Malvern Minerals Co. in Garland County, AR, produced crude and finished material from novaculite. Harbison-Walker Refractories Co. Inc. in Hot Springs County, AR, produced crude and finished tripoli that is consumed in the production of refractory bricks and shapes. Unimin Specialty Minerals Inc. in Alexander County, IL, produced crude and finished material. All these firms except one responded to the USGS survey.

Consumption.—The 2007 USGS annual survey of producers indicated that sales of processed tripoli increased by 27% in quantity to 96,000 t with a value of \$17.4 million (table 1).

Tripoli has unique applications as an abrasive because of its hardness and its grain structure, which lacks distinct edges and corners. It is a mild abrasive, which makes it suitable for use in toothpaste and tooth-polishing compounds, industrial soaps, and metal- and jewelry-polishing compounds. The automobile

industry uses it in buffing and polishing compounds for lacquer finishing.

The end-use pattern for tripoli has changed significantly in the past 30 years. In 1970, nearly 70% of the processed tripoli was used as an abrasive. In 2007, 7% of tripoli output was used as an abrasive. Tripoli was also used in brake friction products, as a filler and extender in enamel, caulking compounds, linings, paint, plastic, refractories, rubber, and other products.

The primary use of tripoli (87%) is as a filler and extender in paints. The remaining 6% of the tripoli used was in brake friction products and refractories.

Price.—The average reported unit value of all tripoli sold or used in the United States was \$181 per ton in 2007. The average reported unit value of abrasive tripoli sold or used in the United States during 2007 was \$203 per ton, and the average reported unit value of filler tripoli sold or used domestically was \$176 per ton.

Outlook.—Consumption patterns for tripoli are not expected to change significantly during the next several years. Most of the existing markets are well defined, and the probability of new uses is low.

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GENERAL SOURCES OF INFORMATION

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- Quartz Crystal. Ch. in Mineral Commodity Summaries, annual.
- Silica Sand. Ch. in United States Mineral Resources, Professional Paper 820, 1973.

Other

- A Stockpile Primer. U.S. Department of Defense, Directorate of Strategic Materials Management, August 1995.
- Aggregates Manager, monthly.
- Ceramics Industry, monthly.
- Electronic Component News, monthly.
- Electronic News, weekly.
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- Engineering and Mining Journal, monthly.
- Glass International, monthly.

TABLE 1
 SALIENT U.S. SILICA STATISTICS¹

(Thousand metric tons and thousand dollars unless otherwise specified)

	2003	2004	2005	2006	2007
Industrial sand and gravel:²					
Sold or used:					
Quantity:					
Sand	26,300	28,700	29,700	28,200 ^r	29,000
Gravel	1,140	1,070	955	725 ^r	1,010
Total	27,500	29,700	30,600	28,900 ^r	30,000
Value:					
Sand	594,000	668,000	733,000	745,000 ^r	808,000
Gravel	15,300	16,600	19,500	22,800 ^r	51,000
Total	609,000	685,000	752,000	768,000 ^r	859,000
Exports:					
Quantity	2,620	1,790	2,910	3,830	3,020
Value	155,000	174,000	154,000	183,000	242,000
Imports for consumption:					
Quantity	440	490	711	855	511
Value	9,210	12,400	18,200	21,000	24,000
Processed tripoli: ³					
Quantity metric tons	68,800	94,000	91,100	76,000	96,400
Value	17,700	19,400	18,700	17,500	17,400
Special silica stone:					
Crude production:					
Quantity metric tons	1,070	227	193	227	231
Value	313	132	191	992	1,020
Sold or used:					
Quantity metric tons	513	655	576	328	508
Value	3,630	3,660	2,290	1,460	823

^rRevised.

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

²Excludes Puerto Rico.

³Includes amorphous silica and Pennsylvania rottenstone.

TABLE 2
 INDUSTRIAL SAND AND GRAVEL SOLD OR USED IN THE UNITED STATES, BY GEOGRAPHIC DIVISION¹

Geographic region	2006				2007			
	Quantity (thousand metric tons)	Percentage of total	Value (thousands)	Percentage of total	Quantity (thousand metric tons)	Percentage of total	Value (thousands)	Percentage of total
Northeast:								
New England	173	1	\$6,290	1	164	1	\$6,000	1
Middle Atlantic	2,220	7	56,200	7	1,780	6	47,900	5
Midwest:								
East North Central	10,600	34 ^r	244,000	31 ^r	9,310	29	240,000	27
West North Central	2,460	8	91,200	12 ^r	2,560	8	102,000	11
South:								
South Atlantic	4,280 ^r	15 ^r	95,300 ^r	12 ^r	4,640	15	133,000	15
East South Central	1,520	5	48,400	6	1,630	5	43,000	5
West South Central	4,660	15	135,000	17	6,490	20	204,000	23
West:								
Mountain	982	3	24,000	3	1,170	4	27,800	3
Pacific	2,010	6	67,800	9 ^r	2,290	7	53,900	6
Total	28,900 ^r	100	768,000 ^r	100	30,000	100	859,000	100

^rRevised.

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

TABLE 3
INDUSTRIAL SAND AND GRAVEL SOLD OR USED IN
THE UNITED STATES, BY STATE¹

(Thousand metric tons and thousand dollars)

State	2006		2007	
	Quantity	Value	Quantity	Value
Alabama	474	18,700	459	9,810
Arizona	W	W	W	W
Arkansas	W	W	W	W
California	1,670	57,800	1,850	43,400
Colorado	W	W	W	W
Florida	500 ^r	8,050 ^r	441	8,110
Georgia	973	17,400	1,040	18,100
Idaho	W	W	W	W
Illinois	5,410	102,000	4,090	86,800
Indiana	W	W	W	W
Iowa	W	W	W	W
Kansas	W	W	W	W
Louisiana	663	16,100	635	21,200
Michigan	1,460	30,400	1,360	30,000
Minnesota	W	W	W	W
Mississippi	W	W	W	W
Missouri	595	16,400	642	19,400
Nevada	W	W	W	W
New Jersey	1,520	40,600	1,070	31,700
New Mexico	184	W	W	W
New York	W	W	W	W
North Carolina	1,220	24,700	1,670	56,600
North Dakota	W	W	W	W
Ohio	1,110	33,800	1,080	33,000
Oklahoma	1,640	40,400	1,710	44,600
Pennsylvania	696	15,500	685	15,800
Rhode Island	W	W	W	W
South Carolina	905	21,800	837	22,000
Tennessee	1,010	29,300	1,070	32,400
Texas	1,530	65,600	3,280	123,000
Virginia	W	W	W	W
Washington	W	W	W	W
West Virginia	333	17,200	345	17,600
Wisconsin	2,450	74,100	2,650	90,100
Other	4,560	138,000	5,120	155,000
Total	28,900 ^r	768,000 ^r	30,000	859,000

^rRevised. W Withheld to avoid disclosing company proprietary data; included in "Other."

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

TABLE 4
INDUSTRIAL SAND AND GRAVEL PRODUCTION IN THE UNITED STATES IN 2007, BY SIZE OF OPERATION¹

Size range	Number of operations	Percentage of total	Quantity (thousand metric tons)	Percentage of total
Less than 25,000	20	17	246	(2)
25,000 to 49,999	13	11	413	1
50,000 to 99,999	16	13	1,060	3
100,000 to 199,999	18	15	2,170	7
200,000 to 299,999	12	10	2,420	8
300,000 to 399,999	9	7	2,850	9
400,000 to 499,999	4	3	1,560	5
500,000 to 599,999	4	3	2,010	6
600,000 to 699,999	5	4	2,930	9
700,000 and more	16	13	14,400	47
Total	117	100	30,000	100

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

²Less than ½ unit.

TABLE 5
NUMBER OF INDUSTRIAL SAND AND GRAVEL OPERATIONS AND PROCESSING PLANTS IN THE UNITED STATES IN 2007, BY GEOGRAPHIC DIVISION

Geographic region	Mining operations on land			Dredging operations	Total active operations
	Stationary	Portable	Stationary and portable		
Northeast:					
New England	1	--	--	--	1
Middle Atlantic	5	--	--	4	9
Midwest:					
East North Central	24	--	--	3	27
West North Central	7	--	--	2	9
South:					
South Atlantic	16	--	--	6	22
East South Central	8	--	--	2	10
West South Central	15	--	--	5	20
West:					
Mountain	6	--	1	--	7
Pacific	11	--	--	1	12
Total	93	--	1	23	117

-- Zero.

TABLE 6
INDUSTRIAL SAND AND GRAVEL SOLD OR USED BY U.S. PRODUCERS IN 2007, BY MAJOR END USE¹

Major use	Northeast			Midwest			South		
	Quantity (thousand metric tons)	Value (thousands)	Unit value ² (dollars per ton)	Quantity (thousand metric tons)	Value (thousands)	Unit value ² (dollars per ton)	Quantity (thousand metric tons)	Value (thousands)	Unit value ² (dollars per ton)
Sand:									
Glassmaking:									
Containers	W	W	21.81	1,390	\$20,800	14.94	1,890	\$35,700	18.92
Flat, plate and window	129	\$2,550	19.79	915	14,200	15.52	1,510	29,700	19.61
Specialty	W	W	30.73	180	3,670	20.39	285	7,910	27.75
Fiberglass, unground	W	W	20.79	267	3,800	14.23	516	8,740	16.94
Fiberglass, ground	--	--	--	50	2,450	49.00	474	23,100	48.75
Foundry:									
Molding and core, unground	93	2,450	26.39	3,340	52,300	15.67	778	14,900	19.12
Molding and core, ground	--	--	--	8	902	112.75	2	200	100.00
Refractory	(3)	8	33.71	21	720	34.29	53	1,460	27.49
Metallurgical:									
Silicon carbide	--	--	--	--	--	--	(3)	W	W
Flux for metal smelting	--	--	--	--	--	--	W	W	6.69
Abrasives:									
Blasting	54	1,250	23.11	51	2,600	50.94	297	11,100	37.23
Scouring cleansers, ground	(3)	1	65.32	(3)	41	55.20	53	2,630	49.53
Sawing and sanding	W	W	37.00	W	W	24.00	W	W	102.00
Chemicals, ground and unground	11	349	31.73	333	5,560	16.68	444	14,000	31.61
Fillers, ground, rubber, paints, putty, etc.	26	304	11.69	251	10,700	42.75	96	11,500	119.76
Whole-grain fillers/building products	368	14,600	39.64	512	15,200	29.72	1,010	28,700	28.34
Ceramic, ground, pottery, brick, tile, etc.	(3)	6	50.21	50	3,460	69.12	130	7,310	56.25
Filtration:									
Water, municipal, county, local	44	2,580	58.52	42	2,450	58.43	78	4,510	57.86
Swimming pool, other	15	1,160	77.47	17	1,440	84.41	63	4,790	76.10
Petroleum industry:									
Hydraulic fracturing	(3)	3	41.43	3,580	181,000	50.59	1,660	77,800	46.77
Well packing and cementing	--	--	--	13	1,410	108.69	1,090	35,300	32.42
Recreational:									
Golf course, greens and traps	138	4,110	29.78	200	4,260	21.31	473	6,170	13.04
Baseball, volleyball, play sand, beaches	21	1,300	62.10	73	2,140	29.37	43	1,110	25.70
Traction, engine	10	323	32.30	28	438	15.64	51	1,200	23.57
Roofing granules and fillers	W	W	31.00	143	3,910	27.34	241	4,660	19.34
Other, ground silica	W	W	50.00	68	2,180	32.01	6	150	25.00
Other, whole grain	1,010	22,000	8.62	156	3,160	20.14	1,100	7,630	6.88
Total or average	1,920	53,000	27.57	11,700	339,000	29.00	12,300	340,000	27.56
Gravel:									
Silicon, ferrosilicon	--	--	--	--	--	--	W	W	124.25
Filtration	W	W	66.45	W	W	10.87	47	2,690	57.15
Other uses, specified	W	W	35.00	W	W	23.21	W	W	24.69
Total or average	16	906	56.63	186	4,030	21.68	421	40,100	95.24
Grand total or average	1,940	53,900	27.81	11,900	343,000	28.88	12,800	380,000	29.79

See footnotes at end of table.

TABLE 6—Continued
INDUSTRIAL SAND AND GRAVEL SOLD OR USED BY U.S. PRODUCERS IN 2007, BY MAJOR END USE¹

Major use	West			U.S. total		
	Quantity (thousand metric tons)	Value (thousands)	Unit value ² (dollars per ton)	Quantity (thousand metric tons)	Value (thousands)	Unit value ² (dollars per ton)
Sand:						
Glassmaking:						
Containers	932	\$19,600	21.02	4,840	\$89,900	18.56
Flat, plate and window	532	12,300	23.14	3,090	58,800	19.01
Specialty	46	495	10.76	632	15,800	24.94
Fiberglass, unground	83	2,120	25.51	968	16,800	17.33
Fiberglass, ground	W	W	40.17	530	25,800	48.68
Foundry:						
Molding and core, unground	65	1,850	28.38	4,280	71,500	16.72
Molding and core, ground	--	--	--	10	1,100	110.20
Refractory	--	--	--	74	2,180	29.51
Metallurgical:						
Silicon carbide	--	--	--	(3)	W	W
Flux for metal smelting	W	W	6.94	W	W	6.82
Abrasives:						
Blasting	96	2,390	24.88	498	17,300	34.72
Scouring cleansers, ground	--	--	--	53	2,670	50.30
Sawing and sanding	--	--	--	7	273	39.00
Chemicals, ground and unground	23	634	27.57	812	20,600	25.34
Fillers, ground, rubber, paints, putty, etc.	W	W	50.00	376	22,600	60.19
Whole grain fillers/building products	643	17,800	27.61	2,540	76,200	30.07
Ceramic, ground, pottery, brick, tile, etc.	W	W	39.33	185	11,000	59.51
Filtration:						
Water, municipal, county, local	39	4,720	121.13	204	14,300	69.93
Swimming pool, other	W	W	287.00	96	7,680	79.98
Petroleum industry:						
Hydraulic fracturing	W	W	91.09	5,260	261,000	49.56
Well packing and cementing	42	1,400	33.24	1,140	38,100	33.31
Recreational:						
Golf course, greens and traps	248	5,410	21.81	1,060	19,900	18.84
Baseball, volleyball, play sand, beaches	40	1,550	38.75	178	6,100	34.29
Traction, engine	20	633	31.65	109	2,600	23.81
Roofing granules and fillers	W	W	23.67	439	10,200	23.18
Other, ground silica	29	1,070	32.73	92	2,970	32.25
Other, whole grain	222	3,870	6.30	1,540	12,700	8.28
Total or average	3,060	75,800	24.74	29,000	808,000	27.84
Gravel:						
Silicon, ferrosilicon	--	--	--	W	W	124.25
Filtration	--	--	--	81	3,670	45.27
Other uses, specified	391	5,920	15.14	W	W	18.66
Total or average	391	5,920	15.14	1,010	51,000	50.30
Grand total or average	3,450	81,700	23.65	30,000	859,000	28.60

W Withheld to avoid disclosing company proprietary data; for sand, included in "Other, ground silica" or "Other, whole grain." -- Zero.

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

²Calculated using unrounded data.

³Less than ½ unit.

TABLE 7
INDUSTRIAL SAND AND GRAVEL SOLD OR USED, BY DESTINATION¹

(Thousand metric tons)

Destination	2006	2007	Destination	2006	2007
States:			States—Continued:		
Alabama	598	511	New Jersey	W	685
Alaska	1	W	New Mexico	W	126
Arizona	38	30	New York	W	W
Arkansas	W	304	North Carolina	W	W
California	W	1,930	North Dakota	W	106
Colorado	1,170	1,260	Ohio	1,070	1,110
Connecticut	71	92	Oklahoma	W	W
Delaware	23	26	Oregon	W	W
District of Columbia	W	W	Pennsylvania	1,250	W
Florida	512	500	Rhode Island	W	W
Georgia	1,140	1,040	South Carolina	W	426
Hawaii	--	W	South Dakota	W	11
Idaho	W	W	Tennessee	647	735
Illinois	2,080	1,430	Texas	W	3,770
Indiana	1,050	999	Utah	41	46
Iowa	W	W	Vermont	W	W
Kansas	W	W	Virginia	262	313
Kentucky	275	284	Washington	W	W
Louisiana	811	776	West Virginia	189	186
Maine	W	W	Wisconsin	1,170	1,150
Maryland	W	W	Wyoming	W	W
Massachusetts	W	W	Countries:		
Michigan	524	518	Canada	560	563
Minnesota	W	W	Mexico	431	351
Mississippi	81	82	Other	W	54
Missouri	287	W	Other:		
Montana	9	20	Puerto Rico	W	W
Nebraska	W	25	U.S. possessions and territories	--	W
Nevada	W	W	Destination unknown	4,130	5,170
New Hampshire	W	W	Total	28,900 ^r	30,000

^rRevised. W Withheld to avoid disclosing company proprietary data; included in "Total." -- Zero.

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

TABLE 8
U.S. EXPORTS OF INDUSTRIAL SAND AND GRAVEL, BY COUNTRY¹

(Thousand metric tons and thousand dollars)

Country	2006		2007	
	Quantity	Value ²	Quantity	Value ²
Africa and the Middle East:				
Egypt	1	1,100	2	1,480
Israel	3	252	(3)	190
Other	3	801	3	1,720
Total	7	2,160	5	3,390
Asia:				
China	48	17,000	32	32,800
Hong Kong	17	822	5	295
Japan	1,080	49,200	946	61,400
Korea, Republic of	4	1,970	11	3,550
Singapore	4	2,630	4	2,170
Taiwan	3	1,420	2	2,080
Other	3	1,730	15	1,460
Total	1,160	74,800	1,020	104,000
Europe:				
Belgium	6	2,200	11	5,030
Germany	46	20,200	33	19,800
Italy	(3)	362	1	859
Netherlands	61	9,840	104	17,600
Russia	(3)	116	(3)	149
United Kingdom	5	3,180	3	4,240
Other	59 ^r	5,970	311	12,700
Total	177	41,900	463	60,400
North America:				
Bahamas, The	(3)	49	42	1,130
Canada	1,530	39,000	1,080	43,300
Mexico	896	10,600	348	13,600
Trinidad and Tobago	2	560	1	280
Other	10	1,030	9	1,520
Total	2,440	51,300	1,480	59,800
Oceania:				
Australia	2	886	2	1,040
New Zealand	(3)	39	(3)	265
Other	--	--	(3)	58
Total	2	924	2	1,360
South America:				
Argentina	35	7,520	39	8,140
Brazil	1	892	3	2,340
Colombia	2	420	2	546
Peru	9	2,060	9	1,230
Venezuela	2	846	2	854
Other	1	241	1	423
Total	50	12,000	56	13,500
Grand total	3,830	183,000	3,020	242,000

^rRevised. -- Zero.

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

²Free alongside ship value of material at U.S. port of export. Based on transaction price, includes all charges incurred in placing material alongside ship.

³Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9
U.S. IMPORTS FOR CONSUMPTION OF INDUSTRIAL
SAND, BY COUNTRY¹

(Thousand metric tons and thousand dollars)

Country	2006		2007	
	Quantity	Value ²	Quantity	Value ²
Australia	3	1,280	3	1,330
Canada	264	9,630	203	12,200
Chile	5	1,320	4	994
China	1	714	4	1,590
Germany	1	373	1	659
Japan	(3)	90	(3)	198
Mexico	580	7,000	292	3,680
Netherlands	(3)	123	(3)	163
Norway	(3)	31	(3)	31
Other	1 ^r	425	4	3,100
Total	855	21,000	511	24,000

^rRevised.

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

²Cost, insurance, and freight value of material at U.S. port of entry. Based on purchase price; includes all charges (except U.S. import duties) in bringing material from foreign country to alongside carrier.

³Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 10
U.S. PRODUCERS OF SPECIAL SILICA STONE PRODUCTS IN 2007

Company and location	Type of operation	Product
B&C Abrasives, Inc., Hot Springs, AR	Stone cutting and finishing	Whetstones and oilstones.
Blue Mountain Whetstone Co., Hot Springs, AR	do.	Do.
Dan's Whetstone Co., Inc., Hot Springs, AR	do.	Do.
Do.	Quarry	Crude novaculite.
Hall's Arkansas Oilstones, Inc., Pearcy, AR	Stone cutting and finishing	Whetstones and oilstones.
Norton Company Oilstones:		
Hot Springs, AR	do.	Do.
Littleton, NH	do.	Do.
Smith Abrasives, Inc., Hot Springs, AR	do.	Do.
Do.	Quarry	Crude novaculite.
Do., do. Ditto.		

TABLE 11
INDUSTRIAL SAND AND GRAVEL (SILICA): WORLD PRODUCTION, BY COUNTRY^{1,2}

(Thousand metric tons)

Country ³	2003	2004	2005	2006
Argentina	301	473 ^r	461 ^r	446 ^r
Australia	4,181	4,142 ^r	5,169 ^r	5,200 ^{r,e}
Austria ^e	6,800	6,800	6,800	6,800
Belgium ^e	1,800	1,800	1,800	1,800
Belize	37	33	22 ^{r,e}	13 ^r
Bosnia and Herzegovina ^e	50	50	50	50
Brazil, silex ^e	1,600	1,600	1,600	1,600
Bulgaria ^e	782 ^r	1,026 ^r	1,229 ^r	1,495 ^r
Canada, quartz	1,581	1,690	1,466 ^r	1,807 ^r
Chile	916	1,085	1,151	1,081 ^r
Croatia ^e	250 ^r	300 ^r	300 ^r	304 ^{r,4}
Cuba ^e	31	33	14	9 ^r
Czech Republic ^e	900	900	900	1,000
Denmark, sales ^e	60	60	60	60
Ecuador	39	32	38	36 ^r
Egypt ^{e,5}	640	640	650	650
Eritrea ^e	(6)	(6)	(6)	(6)
Estonia ^e	42 ^r	-- ^r	-- ^r	-- ^r
Ethiopia ^e	5	5	5 ^{r,e}	5 ^{r,e}
Finland ^e	112	100	100	100
France ^e	6,500	5,300 ^{r,4}	5,100 ^{r,4}	5,000 ^r
Gambia	1,534	1,389	1,390 ^e	1,390
Germany	7,953	8,162	7,681	7,703 ^r
Greece ^e	100	100	100	100
Guatemala	30	1	(6)	58 ^r
Hungary ^e	4,200 ^r	5,900 ^r	7,300 ^r	3,800 ^{r,e}
Iceland ^e	4	4	4	4
India ^e	1,500	1,500	1,600	1,600
Indonesia ^{e,7}	132	132	132	135
Iran ⁸	1,965	1,880	1,900	1,900
Ireland ^e	5	5	5	5
Israel	211	196	196	204 ^r
Italy ^e	12,700 ^r	12,800 ^r	14,400 ^r	13,800 ^r
Jamaica	13	11	14	10 ^r
Japan	4,700	4,705	4,549	4,593 ^r
Jordan ^e	33 ^r	47 ^r	147 ^r	416 ^r
Kenya ^e	13	13	14 ^r	14 ^r
Korea, Republic of	480	554	461	1,437 ^r
Latvia	6 ^{r,e}	7 ^r	18 ^r	13 ^r
Lithuania	50	58	47	42 ^r
Malaysia	534	631	532	512 ^r
Mexico	1,689	2,056	2,121	2,662 ^r
Netherlands ^e	5	5	5	5
New Caledonia ^e	40	40	40	40
New Zealand	48	60	65	59 ^r
Norway ^e	1,500	1,500	1,600	1,500
Pakistan	75 ^e	--	--	-- ⁴
Paraguay ^e	26	25	25	25
Peru	196	871	900 ^e	900 ^e
Philippines	170	237	224	250 ^{r,e}
Poland	2,650 ^r	2,850 ^r	3,270 ^r	3,850 ^r

See footnotes at end of table.

TABLE 11—Continued
INDUSTRIAL SAND AND GRAVEL (SILICA): WORLD PRODUCTION, BY COUNTRY^{1,2}

(Thousand metric tons)

Country ³	2003	2004	2005	2006	2007 ^c
Portugal ^e	5	5	5	5	5
Romania	641 ^r	555 ^r	475 ^r	522 ^r	520
Serbia ^e	260 ^{r,9}	260 ^{r,9}	260 ^{r,9}	260 ^r	260
Slovakia	2,200	2,200 ^e	2,000 ^e	2,000	2,000
Slovenia ^e	200 ^r	200 ^r	200 ^r	200 ^r	200
South Africa	2,311 ^r	2,249 ^r	2,671 ^r	3,234 ^r	3,272 ⁴
Spain ^e	6,500	5,063 ⁸	5,100	5,100	5,000
Sweden ^e	600	700	700	700	700
Thailand	1,294	588	718 ^r	862 ^r	860
Turkey	1,283	1,188	1,200 ^e	1,100 ^{r,e}	1,200
United Kingdom	4,073	5,011	5,200 ^r	5,600 ^r	5,600
United States, sold or used by producers	27,500	29,700	30,600	28,900 ^r	30,000 ⁴
Venezuela	625	943	207	500 ^e	500
Zimbabwe ¹⁰	23	(6)	1	1 ^e	--
Total	117,000 ^r	120,000 ^r	125,000 ^r	123,000 ^r	126,000

^eEstimated. ^rRevised. -- Zero.

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

²Table includes data available through June 20, 2008.

³In addition to the countries listed, Angola, Antigua and Barbuda, The Bahamas, China, countries of the Commonwealth of Independent States, Iraq, and Saudi Arabia produce industrial sand, but current available information is inadequate to formulate reliable estimates of output levels.

⁴Reported figure.

⁵Fiscal years beginning July 1 of that stated.

⁶Less than ½ unit.

⁷The quantities for quartz sand and silica stone, in cubic meters, were as follows: 2003-05—150,000 (estimated); 2006—153,000 (estimated); and 2007—155,000 (estimated).

⁸Fiscal years beginning March 21 of that stated.

⁹Montenegro and Serbia formally declared independence in June 2006 from each other and dissolved their union.

¹⁰Includes rough and ground quartz as well as silica sand.