



2009 Minerals Yearbook

SILICA

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By Thomas P. Dolley

Domestic survey data and tables were prepared by Gregory C. Winters, statistical assistant, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

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 were computed using unrounded data.

Industrial Sand and Gravel

Total industrial sand and gravel production decreased to 24.6 million metric tons (Mt) in 2009 from 30.4 Mt in 2008 (table 1). Industrial sand production decreased by 18%, and industrial gravel production, by 49%.

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 for these sands and gravels are in abrasives, filtration, foundry, glassmaking, 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 decrease for silica sand in 2009 was largely owing to decreased demand as a result of the economic downturn that started in 2008 and continued into 2009. However, increased demand was noted for uses such as sand for water filtration with smaller increases for container glass, specialty glass, golf course sand, and recreational sand. Production of the remaining end uses for silica sand in 2009 experienced declines compared with that of the previous year. Demand for silica gravel declined for all end uses.

Legislation and Government Programs.—Effective January 24, 2008, the Occupational Safety and Health Administration (OSHA) announced a new National Emphasis Program to target worksites where employees are at risk for silicosis. Other elements included in the directive are an evaluation procedure for recording reductions of employee exposures to silica, as well as information on outreach programs, partnerships and alliances with employers to share resources, and training to reduce employee exposure (Occupational Safety and Health Administration, 2008, p. 10).

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 have been the understanding of the regulations and the implementation of the measurements and actions taken to mitigate exposure to crystalline silica and appreciation of the impact of such exposure on the future of many industries (Industrial Minerals, 1998). OSHA created a permissible exposure limit that stipulated the maximum amount of crystalline silica to which workers may be safely exposed during an 8-hour work shift (29 CFR §§1926.55 and 1910.1000). OSHA also established guidelines and training for the proper handling of crystalline silica (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 124 operations known to produce industrial sand and gravel. Of the 124 surveyed operations, 119 (96%) were active, and 5 were idle. The USGS received responses from 78 operations, and their combined production represented 78% of the U.S. total. Production for the 46 nonrespondents was estimated, primarily on the basis of previously reported information supplemented with worker-hour reports from the Mine Safety and Health Administration and information from State agencies.

The Midwest (East North Central and West North Central divisions) led the Nation with 45% of the 24.6 Mt of industrial sand and gravel produced in the United States, followed by the South (South Atlantic, East South Central, and West South Central divisions) with 39%, and the West (Pacific and Mountain divisions) with 9%, and the Northeast (New England and Middle Atlantic) with 7% (table 2).

The leading producing States, in descending order, were Illinois, Wisconsin, Texas, Oklahoma, Michigan, California, North Carolina, and New Jersey (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 total industrial sand and gravel produced, 82% was produced by 47 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.; Badger Mining Corp.; Carmeuse Lime and Stone; Best Sand Corp. (a division of Fairmount Minerals Ltd.); Wisconsin Industrial Sand Co. (a division of Fairmount Minerals Ltd.); Manley Bros. of Indiana, Inc.; Sand Products Corp.; Preferred Rocks of Genoa, LLC; and Kinder Sand Co. Inc. Their combined production represented 78% of the U.S. total.

On November 29, 2008, a fire at Unimin Corp.’s Spruce Pine operation in North Carolina, caused significant damage to the

plant. Most of the damage was in the quartz processing facility with some damage to the feldspar facility. The fire was expected to significantly impact U.S. production of quartz, feldspar, and mica. Unimin Corp. produces an estimated 130,000 t/yr of quartz and feldspar at the facility (Industrial Minerals, 2008).

Consumption.—Industrial sand and gravel production reported by producers to the USGS was material used by the producing companies or sold to their customers. Stockpiled material is not reported until consumed or sold. Of the 24.6 Mt of industrial sand and gravel sold or used, 32% was consumed as glassmaking sand, and 27% as frac sand and sand for well packing and cementing (table 6). Foundry sand consumed 13% of industrial sand and gravel consumption. Other important uses were whole grain fillers and building products (7%) and other whole grain silica (5%).

Minable 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 2009, at least 79% 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 (12.4%), Illinois (5.3%), Wisconsin (4.6%), Colorado (4.3%), Georgia (3.3%), and Indiana (3.2%). Producers reported sending at least 293,000 t of silica to Mexico and 298,000 t to Canada (table 7). Because some producers did not provide this information, their data were estimated or assigned to the “Destination unknown” category. In 2009, 16% of industrial sand and gravel shipped by producers was assigned to that category.

The share of silica sold for all types of glassmaking remained unchanged compared with that of 2008. In 2009, sales to container glass manufacturers declined compared with those in 2008. On average, in the container glassmaking industry, silica accounts for 60% of raw materials used (Industrial Minerals, 2004). The amount of unground silica sand consumed for fiberglass production decreased by 37% compared with that of 2008.

In 2009, sales of sand for flat glass production decreased by 28% compared with those in 2008. Consumption of sand for flat glass declined in all regions of the country in 2009.

Whole grain silica is used in filler-type and building applications. In 2009, consumption of whole-grain fillers for building products was 1.7 Mt, down 23% compared with that in 2008.

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 2009, silica sales for chemical production were 669,000 t, a decrease of about 19% compared with those in 2008. According to the USGS survey, reported sales of silica gravel for silicon and ferrosilicon production, filtration, and other uses, decreased by 49% in 2009 compared with those in 2008. 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, 52% was transported by truck from the plant to the site of first sale or use, unchanged from that of 2008; 35% was transported by rail, up from that of 2008; and 13% by unspecified modes of transport.

Prices.—Compared with the average value of 2008, the average value, free on board plant, of U.S. industrial sand and gravel increased slightly to \$31.90 per metric ton in 2009 (table 6). The average unit values for industrial sand and industrial gravel were \$31.77 per ton and \$37.18 per ton, respectively. The average price for sand ranged from \$10.41 per ton for metallurgical flux for metal smelting to \$131.17 per ton for ground sand for foundry molding and core. For gravel, prices ranged from \$23.65 per ton for silicon and ferrosilicon to \$50.46 per ton for other uses. Producer prices reported to the USGS for silica commonly ranged from several dollars per ton to hundreds of dollars per ton. Prices occasionally exceeded the \$1,000-per-ton level. Nationally, ground sand for foundry molding and core had the highest value (\$131.17 per ton), followed by silica for swimming pool filters (\$91.45 per ton), silica for sawing and sanding (\$79.00 per ton), ground sand used as fillers for paint, putty, and rubber (\$67.31 per ton), sand for well packing and cementing (\$62.48 per ton), ground sand for fiberglass (\$50.82 per ton), and sand for hydraulic fracturing (\$48.87 per ton).

By geographic region, the average value of industrial sand and gravel was highest in the Midwest (\$34.19 per ton), followed by the South (\$30.94 per ton), the Northeast (\$29.34 per ton), and the West (\$26.50 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 \$25.89 per ton in the West to \$17.51 per ton in the Midwest.

Foreign Trade.—Exports of industrial sand and gravel in 2009 decreased by about 31% compared with the amount exported in 2008 and the associated value decreased by 33% (table 8). The decrease in exports can be attributed mainly to decreased demand from markets in Africa and the Middle East, Asia, Europe, and Oceania. Canada was the leading recipient of U.S. exports. The distribution of exports was as follows: 53% to Canada, 20% to Mexico, 18% to Japan, and the remainder to Africa and the Middle East, Europe, Oceania, and South America. The average unit value of exports decreased to \$81 per ton in 2009 from \$84 per ton in 2008. In 2009, export unit values varied widely by region; exports of silica to Oceania averaged \$531 per ton, and exports to the rest of the world averaged \$81 per ton.

Imports for consumption of industrial sand and gravel declined to 95,000 t, which was a decrease of 73% compared with those of 2008 (table 9). Canada supplied 93% of the

silica imports, which averaged \$47 per ton; this price included insurance and freight costs to the U.S. port of entry. The total value of imports was \$8 million, with an average unit value of \$85 per ton. Higher priced imports came from Australia, Chile, China, Germany, and Japan.

World Review.—Based on information provided mainly by foreign governments, world production of industrial sand and gravel was estimated to be 106 Mt (table 10). The United States was the leading producer followed, in descending order, by Italy, Germany, the United Kingdom, Australia, France, Spain, and Poland. Most countries 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 2010 was expected to be 25 to 27 Mt. All forecasts are based on previous performances 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 sand for container glass, golf course, municipal water filtration, recreation, specialty, and whole grain silica. Total demand for all glass sand end uses was expected to remain relatively static through 2010. Industrial sand and gravel sales may also be constrained by diminished demand owing to the continued economic downturn and by the rising energy costs for production and transportation of products.

The demand for foundry sand is dependent mainly on automobile and light truck production. Production and sales of automobiles and light trucks declined in 2009 and the trend continued into 2010. 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, production of silica foundry sand in 2010 was expected to be 3 Mt.

Frac sand sales declined in 2009 compared with those in 2008. On average, crude oil prices decreased in 2009 but started to increase in 2010. Based on this trend, coupled with natural gas exploration in the Eastern United States, demand for frac sand was expected to remain static or increase during 2010 to 7 Mt.

The United States is the leading producer and a major consumer of silica sand and is self-sufficient in this mined commodity. Most silica sand is produced at deposits in the Midwest and near major markets in the Eastern United States. A significant amount of silica sand also is produced in the West and Southwest, mostly in California and Texas, respectively. Domestic production is expected to continue to meet 97% to 98% of demand well beyond 2010. 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 market location 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 relationships for silica sand. Further increases in the development of substitute materials for glass and cast metals could potentially 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 as raw materials for ceramics. Increased efforts to reduce waste and to increase recycling also could likely lower the demand for mined glass sand. Recycling of glass cullet has been increasing in most industrialized nations, and recycling has accounted for anywhere from 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 by approximately 2.5%. During the past 20 years, glass container weight has been reduced by 25% to 40% in many nations, including the United States, decreasing the amount of industrial sand required for each container (Industrial Minerals, 2004). Although other developments could likely cause the demand for silica sand to decrease, the total value of production would likely 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 potentially reduce the demand in many silica markets. The use of silica sand in the abrasive blast industry was being evaluated as a health hazard, and marketers of competing materials, which include garnet, olivine, and slags, encouraged the use of their “safer” abrasive media. In hydraulic fracturing, other materials (such as bauxite-based proppants, ceramic proppants, and resin-coated sand) compete with silica sand, although they are more expensive and not used as extensively as silica sand. Bauxite-based and ceramic proppants exhibit improved performance in deeper, higher pressure formations than silica sand (Industrial Minerals, 2009).

Quartz Crystal

Electronic-grade quartz crystal, also known as cultured quartz crystal, is single-crystal silica with properties that make it uniquely suited for 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 smaller 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 in any given year, approximately 10 billion quartz crystals and oscillators are manufactured and installed worldwide in all types of electronic devices, from automobiles to cellular telephones.

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, 2009, 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 2009, and the Federal Government did 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 2009, no domestic companies reported the production of cultured quartz crystal. During the past several years, cultured quartz crystal was produced predominantly overseas, primarily in Asia.

Consumption.—In 2009, 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, 7 responded to the survey. Consumption for

nonrespondents was estimated based on reports from previous years.

Prices.—The price of as-grown quartz was estimated to be \$100 per kilogram in 2009. Lumbered quartz, which is as-grown cultured quartz that has been processed by sawing and grinding, ranged in price from \$144 per kilogram to more than \$900 per kilogram in 2009, depending on the application.

Foreign Trade.—The U.S. Census Bureau, which is the major Government source of U.S. trade data, does not provide specific import or export statistics on lascas. The U.S. Census Bureau 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, which was inadvertently reported as quartz crystal, not including mounted piezoelectric crystals.

World Review.—Cultured quartz crystal production was concentrated in China, Japan, and Russia; several companies produced crystal in each country. Other producing countries were 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 were 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 likely 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 consisted of silicon on insulated wafers. MEMS technology is physically compatible with existing quartz oscillator products and has better long-term stability performance characteristics for use in automotive, consumer, and 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.—None of the three domestic firms known to produce special silica stone responded to a USGS production survey in 2009. To protect the proprietary data of all producers, production and value data for special silica stone in 2009 were

withheld (table 1). In recent years, Arkansas accounted for most of the value and quantity of production that was reported. Plants in Arkansas manufactured files, deburring-tumbling media, oilstones, and whetstones.

The industry 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 comprises a combination of craft, household, industrial, and leisure uses. The leading household use is for sharpening knives and other cutlery, lawn and garden tools, scissors, and shears. Major industrial uses include deburring metal and plastic castings, polishing metal surfaces, and sharpening and honing cutting surfaces. The major recreational use is in sharpening arrowheads, fishhooks, spear points, and sports knives. The leading craft application is sharpening tools for engraving, jewelry making, and woodcarving. Silica stone files also are used in the manufacture, modification, and repair of firearms.

Prices.—In 2009, the average value of crude material suitable for cutting into finished products was estimated to be \$3,700 per ton.

Foreign Trade.—In 2009, silica stone product exports had a value of \$7.6 million, down by 13% from that in 2008. These exports were categorized as “hand sharpening or polishing stones” by the U.S. Census Bureau. This category accounted for most of or all the silica stone products exported in 2009.

In 2009, the value of imported silica stone products was \$8.3 million, down by 11% from that in 2008. These imports were hand sharpening or polishing stones, which accounted for most of or all the imported silica stone products in 2009. 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 were not expected to change significantly during the next several years. Most of the existing markets are well defined, and the probability of new uses being created 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 on 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 2009, five U.S. firms were known to produce and process tripoli. American Tripoli, Inc. 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. 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. Of the five U.S. firms, two responded to the USGS survey. Production for nonrespondents was estimated based on reports from previous years.

Consumption.—The 2009 USGS annual survey of producers indicated that sales of processed tripoli decreased by 40% in quantity to 79,700 t with a value of \$16.4 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 40 years. In 1970, nearly 70% of the processed tripoli was used as an abrasive. In 2009, 6% of tripoli output was used as an abrasive. Tripoli also was used in brake friction products and as a filler and extender in enamel, caulking compounds, linings, paint, plastic, refractories, rubber, and other products.

In 2009, the primary use of tripoli (91%) was as a filler and extender in paints. The remaining 3% was in brake friction products and refractories.

Price.—The average reported unit value of all tripoli sold or used in the United States was \$206 per ton in 2009. The average reported unit value of abrasive-grade tripoli sold or used in the United States during 2009 was \$217 per ton, and the average reported unit value of filler-grade tripoli sold or used domestically was \$211 per ton.

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

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GENERAL SOURCES OF INFORMATION

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TABLE 1
 SALIENT U.S. SILICA STATISTICS¹

(Thousand metric tons and thousand dollars unless otherwise specified)

	2005	2006	2007	2008	2009
Industrial sand and gravel:²					
Sold or used:					
Quantity:					
Sand	29,700	28,200	29,000	29,300	24,000
Gravel	955	725	1,010	1,110	565
Total	30,600	28,900	30,100	30,400	24,600
Value:					
Sand	733,000	745,000	810,000	909,000	762,000
Gravel	19,500	13,400	21,300	28,000	21,000
Total	752,000	759,000	832,000	940,000	783,000
Exports:					
Quantity	2,910	3,830	3,020	3,100	2,150
Value	154,000	183,000	242,000	260,000	175,000
Imports for consumption:					
Quantity	711	855	511	355	95
Value	18,200	21,000	24,000	23,500	8,080
Processed tripoli: ³					
Quantity metric tons	91,100	76,000	96,400	132,000	79,700
Value	18,700	17,500	17,400	17,100	16,400
Special silica stone:					
Crude production:					
Quantity metric tons	193	227	231	W	W
Value	191	992	1,020	W	W
Sold or used:					
Quantity metric tons	576	328	508	W	W
Value	2,290	1,460	823	W	W

W Withheld to avoid disclosing company proprietary data.

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	2008				2009			
	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	147	(2)	\$5,160	(2) [†]	130	(2)	\$4,510	(2)
Middle Atlantic	1,710	6	48,600	5	1,670	7	48,200	6
Midwest:								
East North Central	9,890	33	291,000	31	8,470	34	266,000	34
West North Central	2,600	9	120,000	13	2,630	11	113,000	14
South:								
South Atlantic	4,250	14	102,000	11	3,480	14	89,900	11
East South Central	1,660	5	48,200	5	1,210	5	39,200	5
West South Central	7,230	24	243,000	26	4,780	19	164,000	21
West:								
Mountain	1,030	3	30,200	3	531	2	12,600	2
Pacific	1,920	6	52,700	6	1,670	7	45,600	6
Total	30,400	100	940,000	100	24,600	100	783,000	100

[†]Revised.

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

²Less than ½ unit.

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

(Thousand metric tons and thousand dollars)

State	2008		2009	
	Quantity	Value	Quantity	Value
Alabama	619	14,600	370	11,200
Arizona	W	W	W	W
Arkansas	W	W	W	W
California	1,500	42,300	1,300	35,800
Colorado	W	W	W	W
Florida	573	7,480	431	8,270
Georgia	841	20,700	775	19,300
Idaho	W	W	W	W
Illinois	3,980	108,000	3,440	104,000
Indiana	W	W	W	W
Iowa	W	W	W	W
Kansas	W	W	W	W
Louisiana	748	23,100	682	25,900
Maryland	W	W	--	--
Michigan	1,500	26,800	1,330	27,700
Minnesota	W	W	W	W
Mississippi	W	W	W	W
Missouri	648	21,400	763	28,900
Nebraska	--	--	W	W
Nevada	W	W	W	W
New Jersey	1,010	31,800	906	30,200
New Mexico	W	W	--	--
New York	W	W	W	W
North Carolina	1,510	29,400	1,300	28,000
North Dakota	W	W	W	W
Ohio	1,010	34,300	849	26,300
Oklahoma	2,040	63,700	1,410	40,300
Pennsylvania	677	16,300	618	15,600
Rhode Island	W	W	W	W
South Carolina	679	21,100	441	14,000
Tennessee	983	32,800	783	27,100
Texas	3,590	139,000	2,130	84,400
Virginia	W	W	W	W
Washington	W	W	W	W
West Virginia	338	17,200	241	14,700
Wisconsin	3,290	120,000	2,730	105,000
Other	4,910	171,000	4,070	137,000
Total	30,400	940,000	24,600	783,000

W Withheld to avoid disclosing company proprietary data; included in "Other." -- Zero.

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 2009, BY SIZE OF OPERATION¹

Size range	Number of operations	Percentage of total	Quantity (thousand metric tons)	Percentage of total
Less than 25,000	19	16	228	(2)
25,000 to 49,999	14	11	461	1
50,000 to 99,999	19	16	1,150	4
100,000 to 199,999	20	16	2,600	10
200,000 to 299,999	14	11	3,050	12
300,000 to 399,999	8	6	2,350	9
400,000 to 499,999	6	5	2,400	9
500,000 to 599,999	4	3	W	W
600,000 to 699,999	9	7	5,240	21
700,000 and more	6	5	W	W
Total	119	100	24,600	100

W Withheld to avoid disclosing company proprietary data; included in "Total."

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 2009, 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	4	--	--	4	8
Midwest:					
East North Central	23	--	3	3	29
West North Central	9	--	--	2	11
South:					
South Atlantic	17	1	--	4	22
East South Central	8	--	--	2	10
West South Central	16	--	--	7	22
West:					
Mountain	4	--	1	--	5
Pacific	11	--	--	--	11
Total	93	1	4	22	119

-- Zero.

TABLE 6
INDUSTRIAL SAND AND GRAVEL SOLD OR USED BY U.S. PRODUCERS IN 2009, 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	608	14,700	\$24.11	1,180	\$20,600	\$17.51	1,750	\$35,400	\$20.18
Flat, plate and window	107	2,340	21.91	W	W	16.92	985	21,700	22.01
Specialty	93	3,160	34.00	284	6,110	21.52	175	6,120	34.95
Fiberglass, unground	W	W	21.58	146	2,390	16.34	286	5,890	20.58
Fiberglass, ground	--	--	--	28	1,870	66.71	276	13,600	49.21
Foundry:									
Molding and core, unground	82	2,230	27.20	2,490	45,600	18.29	451	10,100	22.29
Molding and core, ground	--	--	--	5	714	142.80	(3)	73	112.00
Refractory	(3)	5	40.00	16	745	46.56	28	889	31.75
Metallurgical, flux for metal smelting	--	--	--	--	--	--	W	W	23.67
Abrasives:									
Blasting	45	1,060	23.64	34	1,980	58.35	281	13,100	46.73
Sawing and sanding	W	W	103.00	--	--	--	W	W	55.00
Chemicals, ground and unground	2	84	42.00	231	4,660	20.17	438	16,300	37.25
Fillers, ground, rubber, paints, putty, etc.	7	405	57.86	219	9,920	45.31	W	W	226.68
Whole-grain fillers/building products	292	11,300	38.86	365	14,400	39.45	784	25,900	33.02
Ceramic, ground, pottery, brick, tile, etc.	--	--	--	30	2,250	75.00	57	4,600	80.70
Filtration:									
Water, municipal, county, local	42	2,850	67.74	147	2,590	17.63	48	2,880	59.94
Swimming pool, other	12	1,000	83.33	17	1,410	83.00	39	3,900	99.97
Petroleum industry:									
Hydraulic fracturing	W	W	35.94	4,680	235,000	50.19	1,770	81,300	46.01
Well packing and cementing	--	--	--	28	2,200	78.71	70	3,020	43.14
Recreational:									
Golf course, greens and traps	151	3,790	25.11	217	5,210	23.99	378	6,150	16.26
Baseball, volleyball, play sand, beaches	24	1,010	41.88	55	1,730	31.38	41	1,300	31.73
Traction, engine	14	539	38.50	21	394	18.76	33	919	27.85
Roofing granules and fillers	W	W	35.46	113	3,790	33.57	236	4,960	21.00
Other, ground silica	W	W	50.00	7	185	26.43	97	8,220	18.02
Other, whole grain	290	6,370	15.76	695	12,800	22.86	851	11,900	13.92
Total or average	1,770	51,000	28.78	11,000	376,000	34.19	9,070	278,000	30.65
Gravel:									
Silicon, ferrosilicon	--	--	--	W	W	17.00	211	5,010	23.76
Filtration	W	W	71.20	W	W	20.07	W	W	53.32
Other uses, specified	7	767	109.57	64	2,600	40.63	151	8,140	53.91
Total or average	21	1,650	78.57	94	3,210	34.17	395	14,800	37.53
Grand total or average	1,800	52,700	29.34	11,100	380,000	34.19	9,470	293,000	30.94

See footnotes at end of table.

TABLE 6—Continued
INDUSTRIAL SAND AND GRAVEL SOLD OR USED BY U.S. PRODUCERS IN 2009, 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	791	\$20,500	\$25.89	4,330	\$91,100	\$21.05
Flat, plate and window	468	12,100	25.79	2,080	44,900	21.59
Specialty	W	W	54.00	556	15,600	28.07
Fiberglass, unground	W	W	24.59	509	10,200	19.95
Fiberglass, ground	W	W	44.25	311	15,800	50.82
Foundry:						
Molding and core, unground	101	2,150	21.30	3,130	60,100	19.20
Molding and core, ground	--	--	--	6	787	131.17
Refractory	--	--	--	44	1,640	37.25
Metallurgical, flux for metal smelting	W	W	7.57	W	W	10.41
Abrasives:						
Blasting	69	1,030	14.90	430	17,200	40.02
Sawing and sanding	--	--	--	W	W	79.00
Chemicals, ground and unground	11	328	29.82	669	21,100	31.48
Fillers, ground, rubber, paints, putty, etc.	W	W	49.33	260	17,500	67.31
Whole grain fillers/building products	278	9,120	32.82	1,720	60,800	35.35
Ceramic, ground, pottery, brick, tile, etc.	W	W	42.50	88	6,940	78.81
Filtration:						
Water, municipal, county, local	15	747	49.80	251	9,060	36.10
Swimming pool, other	--	--	--	69	6,310	91.45
Petroleum industry:						
Hydraulic fracturing	W	W	34.73	6,530	319,000	48.87
Well packing and cementing	14	1,770	126.71	112	7,000	62.48
Recreational:						
Golf course, greens and traps	188	4,070	21.65	935	19,200	20.55
Baseball, volleyball, play sand, beaches	W	W	27.57	127	4,230	33.28
Traction, engine	4	173	43.25	73	2,020	27.73
Roofing granules and fillers	W	W	40.50	382	9,900	25.92
Other, ground silica	23	973	38.60	87	1,960	22.53
Other, whole grain	181	3,980	11.45	1,300	19,900	15.33
Total or average	2,140	56,900	26.57	24,000	762,000	31.77
Gravel:						
Silicon, ferrosilicon	W	W	23.47	258	6,100	23.65
Filtration	--	--	--	W	W	42.10
Other uses, specified	W	W	29.67	W	W	50.46
Total or average	55	1,320	24.04	565	21,000	37.18
Grand total or average	2,200	58,200	26.50	24,600	783,000	31.90

W Withheld to avoid disclosing company proprietary data; for sand, included in "Other, ground silica" or "Other, whole grain"; for gravel, included in "Total or average." -- 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	2008	2009	Destination	2008	2009
States:			States—Continued:		
Alabama	405 ^r	361	New Jersey	W	W
Alaska	W	W	New Mexico	130	90
Arizona	W	W	New York	W	W
Arkansas	536	748	North Carolina	W	W
California	W	W	North Dakota	185	167
Colorado	1,470	1,050	Ohio	696	588
Connecticut	72	67	Oklahoma	987	516
Delaware	23	30	Oregon	W	65
District of Columbia	W	W	Pennsylvania	W	W
Florida	W	657	Rhode Island	25	22
Georgia	829	788	South Carolina	W	W
Hawaii	W	W	South Dakota	W	W
Idaho	W	W	Tennessee	599	471
Illinois	1,350	1,280	Texas	4,600	3,020
Indiana	917	792	Utah	18	W
Iowa	W	W	Vermont	W	W
Kansas	289	194	Virginia	214	172
Kentucky	W	W	Washington	W	W
Louisiana	472	480	West Virginia	W	74
Maine	W	W	Wisconsin	1,390	1,130
Maryland	W	W	Wyoming	312	371
Massachusetts	106	W	Countries:		
Michigan	427	341	Canada	467	298
Minnesota	W	W	Mexico	357	293
Mississippi	79	52	Other	12	7
Missouri	W	W	Other:		
Montana	9	9	Puerto Rico	W	W
Nebraska	W	W	U.S. possessions and territories	W	W
Nevada	W	W	Destination unknown	5,420	3,940
New Hampshire	W	W	Total	30,400	24,300

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

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 REGION AND COUNTRY¹

(Thousand metric tons and thousand dollars)

Destination	2008		2009	
	Quantity	Value ²	Quantity	Value ²
Africa and the Middle East:				
Egypt	(3)	147	--	--
Israel	2	511	(3)	301
Other	9	948	6	938
Total	11	1,610	7	1,240
Asia:				
China	106	55,700	23	36,000
Hong Kong	1	375	(3)	267
Japan	1,200	50,100	396	15,500
Korea, Republic of	22	4,490	9	2,950
Singapore	1	776	1	966
Taiwan	3	1,660	4	1,210
Other	(3)	1,010	4	984
Total	1,340	114,000	437	57,800
Europe:				
Belgium	23	10,600	3	1,640
Germany	39	16,800	34	19,800
Italy	2	751	1	700
Netherlands	145	7,000	52	4,260
Russia	(3)	39	(3)	20
United Kingdom	4	4,800	5	2,430
Other	46	12,100	5	10,700
Total	259	52,000	100	39,500
North America:				
Bahamas, The	(3)	77	(3)	82
Canada	1,010	54,700	1,150	43,200
Mexico	417	19,000	420	22,600
Trinidad and Tobago	1	211	1	410
Other	5	1,530	5	1,260
Total	1,440	75,500	1,580	67,500
Oceania:				
Australia	2	1,050	2	993
New Zealand	(3)	85	(3)	69
Other	1	204	--	--
Total	3	1,340	2	1,060
South America:				
Argentina	26	7,810	17	3,390
Brazil	4	850	3	1,480
Colombia	1	391	4	1,650
Peru	21	4,620	2	445
Venezuela	2	1,070	(3)	264
Other	1	444	2	418
Total	55	15,200	28	7,640
Grand total	3,100	260,000	2,150	175,000

-- 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	2008		2009	
	Quantity	Value ²	Quantity	Value ²
Australia	2	1,030	(3)	567
Canada	244	15,900	88	4,170
Chile	1	374	(3)	62
China	(3)	173	(3)	160
Germany	(3)	384	(3)	143
Japan	(3)	29	(3)	47
Mexico	103	3,590	5	2,540
Netherlands	(3)	134	(3)	30
Norway	(3)	48	--	--
Other	5	1,830	1	372
Total	355	23,500	95	8,080

-- Zero.

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

(Thousand metric tons)

Country ³	2005	2006	2007	2008	2009 ^e
Argentina	461	446	457 ^r	473 ^r	450
Australia ^e	5,169 ⁴	5,200	5,300	5,300	5,200
Austria	1,610	2,008	1,890 ^r	2,150 ^r	1,500
Belgium ^e	1,800	1,800	1,800	1,800	1,800
Belize ^e	18 ⁴	11	12	12	12
Bosnia and Herzegovina	120 ^r	711 ^r	671 ^r	702 ^r	700
Brazil, silex ^e	2 ^r	2 ^r	2 ^r	2	2
Bulgaria	583 ^r	250 ^r	551 ^r	734 ^r	650
Canada, quartz	1,466	2,146	1,987	1,979	1,296 ⁴
Chile	1,151	1,081	1,234	1,401	1,405 ⁴
Croatia	131 ^r	140 ^r	148 ^r	150 ^{r,e}	150
Cuba ^e	14	9	21 ^r	29 ^r	30
Czech Republic, foundry sand	807 ^r	773 ^r	850 ^r	702 ^r	1,364 ⁴
Denmark, sales ^e	60	60	60	60	60
Ecuador	38	36	36 ^e	36 ^e	36
Egypt ^{e,5}	650	650	1,725 ^{r,4}	1,612 ^{r,4}	1,750
Eritrea ^e	(6)	(6)	(6)	(6)	(6)
Ethiopia ^{e,7}	5 ^r	6 ^r	6 ^{r,4}	7 ^{r,4}	7
Finland	2,860 ^r	3,003 ^r	2,958 ^r	3,160 ^r	2,241 ⁴
France ^e	5,100 ⁴	5,000	5,000	5,000	5,000
Gambia ^e	1,390	1,390	712 ^{r,4}	1,065 ^{r,4}	1,100
Germany	7,681	7,703	8,382	8,186	6,453 ⁴
Greece ^e	100	100	100	65 ^{r,4}	38 ⁴
Guatemala	(6)	58	68	65 ^r	36 ⁴
Hungary	138 ^r	120 ^r	117 ^r	100 ^{r,e}	290
Iceland ^e	4	4	4	4	4
India ^e	1,600	1,600	1,600	1,700	1,700
Indonesia ^e	132	135	135	138	138
Iran ⁸	1,900	1,900	2,000 ^e	2,000 ^e	1,500
Ireland ^e	5	5	5	5	5
Israel	196	204	220	147 ^r	150
Italy	14,400	13,800	13,800 ^e	13,800 ^e	13,800
Jamaica	14	10	14	15 ^r	7 ⁴
Japan	4,549	4,593	4,314	3,664 ^r	3,500
Jordan	229	392	628	650 ^e	700
Kenya ^e	34	34	34	34	34
Korea, Republic of	461	1,437	2,227 ^r	1,757 ^r	455 ⁴
Latvia	18	13	13 ^e	12 ^e	12
Lithuania	47	43 ^r	45	38 ^r	41 ⁴
Malaysia	532	512	719	1,467 ^r	161 ^{p,4}
Mexico	2,121	2,662	2,700 ^e	2,779	2,770
Netherlands ^e	5	5	5	5	5
New Caledonia ^e	40	40	40	40	40
New Zealand	65	59	86	49 ^r	50
Nigeria	--	--	--	26	32 ⁴
Norway ^e	1,600	1,500	1,500	1,500	1,500
Paraguay ^e	25	25	25	25	25
Peru ^e	900	900	900	900	900
Philippines	224	179	141 ^r	172 ^r	185 ⁴
Poland	3,270	3,850	4,000 ^e	4,000 ^e	4,385 ⁴
Portugal ^e	5	5	5	5	5
Romania	475	522	520 ^e	520 ^e	520

See footnotes at end of table.

TABLE 10—Continued
INDUSTRIAL SAND AND GRAVEL (SILICA): WORLD PRODUCTION, BY COUNTRY^{1,2}

(Thousand metric tons)

Country ³	2005	2006	2007	2008	2009 ^e
Saudi Arabia	--	--	--	799	--
Serbia ^e	260 ⁹	260	260	260	260
Slovakia ^e	2,000	2,000	2,000	2,000	620
Slovenia ^e	200	200	200	200	200
South Africa	2,671	3,231	3,352 ^r	3,544 ^r	2,306 ⁴
Spain ^e	5,100	5,100	5,000	5,000	5,000
Sri Lanka	--	46	70	61	60 ⁴
Sweden ^e	700	700	700	700	700
Thailand	718	862	844 ^r	496 ^r	600
Turkey	1,467 ^r	1,872 ^r	2,147 ^r	2,100 ^{r,e}	1,250
United Kingdom	5,200	5,600	5,600 ^e	5,600 ^e	5,600
United States, sold or used by producers	30,600 ^r	28,900	30,100	30,400	24,600 ⁴
Venezuela ^e	207 ⁴	500	500	500	500
Zimbabwe ¹⁰	1	1 ^e	--	--	--
Total	113,000 ^r	116,000 ^r	120,000 ^r	122,000 ^r	106,000

^eEstimated. ^pPreliminary. ^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 17, 2009.

³In addition to the countries listed, Angola, Antigua and Barbuda, The Bahamas, China, countries of the Commonwealth of Independent States, and Iraq 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.

⁷Ethiopian calendar year ending July 7 of that stated.

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.