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SILICA [ADVANCE RELEASE]

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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 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 in the United States increased to 62.1 million metric tons (Mt) in 2013 from 50.6 Mt in 2012 (table 1). Industrial sand production increased by 23%, and industrial gravel production decreased by 20%, compared with that of 2012. The value of production in 2013 was $3.47 billion—a 30% increase from that of 2012 and a record-high value for industrial sand and gravel production. Estimated world production of industrial sand and gravel in 2013 was 142 Mt, a 9% increase compared with 2012 production (table 10).

As in the past several years, the most important driving force in the industrial sand and gravel industry remained the production and sale of hydraulic fracturing sand (frac sand). Considering the past several years, it would be difficult to overemphasize the effect that frac sand has had on the industrial sand and gravel industry, as production tonnage of frac sand in the 10-year period ending in 2013 was about 19 times higher than in 2003. In 2013, frac sand use increased by 32% compared with that of 2012.

The consumption of frac sand has increased greatly as hydrocarbon exploration in the United States has shifted to natural gas and petroleum trapped in shale deposits. It has been estimated that by 2018, hydraulic fracturing could be used to produce 23% of petroleum and 57% of natural gas in the United States (Industrial Minerals, 2012).

Industrial sand and gravel, often called “silica,” “silica sand,” and “quartz sand,” includes sands and gravels with high silicon dioxide (SiO_2) content. Some examples of end uses for these sands and gravels are in abrasives, filtration, foundry, glassmaking, hydraulic fracturing, and silicon metal applications. The specifications for each use differ, 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.

Legislation and Government Programs.—One of the most important issues affecting the industrial minerals industry has been the potential effect of crystalline silica on human health. The understanding of the regulations, the implementation of the measurements and actions taken to mitigate exposure to crystalline silica, and the appreciation of the effect of such exposure on the future of many industries, remained central to an ongoing and often heated debate. The Occupational Safety and Health Administration (OSHA) enforces permissible exposure limits that stipulate 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 provides guidelines and training tools for the proper handling of crystalline silica (Occupational Safety and Health Administration, 2002).

After many years of study, OSHA issued a Notice of Proposed Rulemaking (NPRM) for Occupational Exposure to Respirable Crystalline Silica in the Federal Register on September 12, 2013. The NPRM was a proposal and not a final rule. OSHA stated that the proposed rule was the result of extensive review of scientific evidence relating to the health risks of exposure to respirable crystalline silica, analysis of the diverse industries where worker exposure to crystalline silica occurs, robust outreach efforts to affected stakeholders, and careful consideration of current industry consensus standards for crystalline silica exposure. OSHA stated that current permissible exposure limits for crystalline silica were inadequate. The time period for public and stakeholder comments and participation on the NPRM extended into 2014 (Occupational Safety and Health Administration, 2013).

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 118 producers with 183 operations known to produce industrial sand and gravel. Of the 183 surveyed operations, 182 (99%) were active, and 1 was idle. The USGS received responses from 76 operations, and their combined production represented 67% of the U.S. total tonnage. Production data for the nonrespondents were estimated, primarily on the basis of previously reported information, supplemented with worker-hour reports from the Mine Safety and Health Administration (MSHA) and information from State agencies.

The production increase for silica sand in 2013, as reported to the USGS from a voluntary survey by U.S. producers, was largely attributable to increasing demand for frac sand, which resulted in production capacity increases and the opening of new frac sand operations in the United States.

The Midwest (East North Central and West North Central divisions) led the Nation with 66% of the 62.1 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 28%, the West (Pacific and Mountain divisions) with 4%, and the Northeast (New England and Middle Atlantic) with 2% (table 2).

The leading producing States were, in descending order, Wisconsin, Illinois, Texas, Minnesota, Arkansas, Oklahoma, Missouri, North Carolina, Ohio, and Michigan (table 3). Their combined production accounted for 82% of the national total. States for which data were withheld in table 3 were not included among the leading producers.

Of the total industrial sand and gravel produced, 90% was produced at 79 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 Holdings, Inc.; Fairmount Minerals, Ltd.; Emerge Energy Services LP; Great Northern Sand; Badger Mining Corp.; Pattison Sand Co., LLC; Preferred Sands; Fred Weber Inc.; and Texsand Silica, Ltd. Their combined production represented 64% of the U.S. total.

Owing to increasing frac sand demand in the past several years, some energy companies operate and (or) own frac sand operations in order to reduce costs and ensure a reliable supply of frac sand for their drilling operations. Additionally, in the past several years, the consumption increase in frac sand has spurred many industrial sand and gravel companies to vertically integrate their operations. Vertical integration is when a company owns facilities involved with every step of the supply chain. Each component of the supply chain produces a different product or service and the products combine to satisfy a common need, thereby reducing transportation costs and reducing turnaround time. For example, in 2013 Preferred Sands owned a fleet of about 4,500 rail cars for the distribution of frac sand, which is transported by several railroad companies. In 2013, U.S. Silica Holdings, Inc. and BSNF Railway Co. jointly opened a 15,000-metric-ton (t) frac sand storage facility in San Antonio, TX, to support companies drilling in the nearby Eagle Ford Shale (Industrial Minerals, 2013a). On May 1, 2013, Emerge Energy Services LP, a diversified energy supply company, filed an initial public offering with the U.S. Securities and Exchange Commission (Emerge Energy Services LP, 2013). In addition to fuel processing and distribution, Emerge Energy Services LP also owns several frac sand mining operations in Texas and the Superior Silica mine in Wisconsin.

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 62.1 Mt of industrial sand and gravel sold or used, 67% was consumed as frac sand and sand for well packing and cementing and 14% as glassmaking sand (table 6). Foundry uses accounted for 7% of industrial sand and gravel consumption. Other leading uses were whole grain fillers for building products (3%), other whole grain silica (3%), and chemicals (2%). Abrasives, ceramics, fillers, filtration, metallurgical flux, other ground silica, recreational sand, roofing granules, silica gravel, and traction sand accounted for about 4% of industrial sand and gravel end uses. Increased consumption was noted for uses such as ceramics, chemicals, container glass, fillers, frac sand, municipal water filtration, other ground silica, recreational sand, traction sand, unground sand for fiberglass, well packing and cementing, whole grain silica for fillers, building products, and other uses. Production of silica sand for the remaining end uses in 2013 declined compared with that of 2012. With the exception of a steep decline for filtration, demand for silica gravel increased slightly for all end uses.

Minable deposits of industrial sand and gravel occur throughout the United States, and mining operations are located near markets that have traditionally been in the Eastern United States. In some cases, consuming industries are intentionally located near a silica resource. For example, 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 2013, 86% of foundry sand was produced in the Midwest (table 6).

The Ordovician St. Peter Sandstone in the Midwest is a primary source of silica sand for many end uses, including frac sand. Mined in five States, frac sand from the St. Peter Sandstone is within reasonable transport distance to numerous underground shale formations producing natural gas. In 2013, 78% of frac sand was produced in the Midwest. Additional significant sources of frac sand include the Cambrian Jordan Sandstone in Minnesota and the Cambrian Hickory Sandstone in Texas (Industrial Minerals, 2007).

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 the State or other location to which the material was shipped for consumption. All States received industrial sand and gravel. The States that received the most industrial sand and gravel were, in descending order, Texas, Wisconsin, Pennsylvania, Ohio, Oklahoma, Illinois, North Carolina, California, Arkansas, and Tennessee. Producers reported sending 175,000 t of silica to Mexico (table 7). Because some producers did not provide this information, their data were estimated or assigned to the "Destination unknown" category. In 2013, 47% of industrial sand and gravel shipped by producers was assigned to that category.

The share of silica sold for all types of glassmaking increased by 4% compared with that of 2012. Sales of sand for container glass production increased by 12% in 2013 and sales to flat glass manufacturers decreased by 3% compared with those in 2012. 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 increased by 25%, ground silica sand consumed for fiberglass production decreased by 19%, and sales for specialty glass decreased by 16%, compared with those of 2012.

The demand for foundry sand is dependent mainly on automobile and light truck production. Although production and sales of automobiles and light trucks increased in 2013, sales of foundry sand decreased by 4% compared with those of 2012.

Whole grain silica is regularly used in filler-type and building applications. In 2013, consumption of whole-grain fillers for building products was 1.71 Mt, a slight increase compared with that of 2012.

In 2013, silica sand sales for chemical production were 1.15 Mt, an increase of about 29% compared with those in 2012. Total sales of silica gravel for silicon and ferrosilicon production, filtration, and other uses, decreased by 20% in 2013 compared with those in 2012. The main uses for silicon metal are in the manufacture of silanes and semiconductor-grade silicon and in the production of aluminum alloys.

Transportation.—The increase of frac sand production and sales had a profound effect on the transportation of industrial sand and gravel to sites of first use. According to the USGS voluntary survey of U.S. producers, of all industrial sand and gravel produced, 60% was transported by truck from the plant to the site of first sale or use, down by 15% from that of 2012; 36% was transported by rail, up by 71% from that of 2012 (owing to increased frac sand shipments); and 4% was transported by unspecified modes of transport.

Prices.—The average value, free on board plant, of U.S. industrial sand and gravel increased to $55.76 per metric ton in 2013, a 6% increase compared with the average value of $52.80 per metric ton in 2012 (table 6). Average values increased for some end uses and decreased for others, but substantial increases for the leading end uses resulted in overall increased unit values. The average unit values for industrial sand and industrial gravel were $55.86 per ton and $33.86 per ton, respectively. The average unit value for sand ranged from $23.21 per ton for other whole grain silica to $64.15 per ton for frac sand. For gravel, unit values ranged from $24.02 per ton for silicon and ferrosilicon to $47.40 per ton for filtration. Nationally, frac sand had the highest value ($64.15 per ton), followed by ground sand used for foundry molding and core ($62.56 per ton), sand for municipal water filtration ($59.23 per ton), ground sand for fiberglass ($55.68 per ton), silica sand for ceramics ($52.58 per ton), sand for specialty glass ($51.62 per ton), and ground sand used as filler for paint, putty, and rubber ($50.73 per ton).

In any given year, producer prices reported to the USGS for silica sand commonly ranged from several dollars per ton to hundreds of dollars per ton. Prices for certain high-purity quartz products for specialized end uses, not covered in this chapter, can reach the $5,000-per-ton level. These specialized end uses include fused quartz crucibles (for the manufacture of silicon metal ingots that are later processed into silicon wafers for the photovoltaic cell and semiconductor markets), solar power cells, high-temperature lamp tubing, and telecommunications uses (Industrial Minerals, 2013b).

By geographic region, the average value of industrial sand and gravel was highest in the Midwest ($58.91 per ton), followed by the South ($51.31 per ton), the West ($44.06 per ton), and the Northeast ($41.51 per ton) (table 6). Prices can vary greatly for similar grades of silica sand at various locations in the United States, owing to tighter supplies and higher production costs in certain regions of the country. For example, the average value of container glass sand varied from $30.77 per ton in the Midwest to $49.16 per ton in the West.

Foreign Trade.—Exports of industrial sand and gravel in 2013 decreased by 32% compared with the amount exported in 2012, but the associated value increased by about 7% (table 8). Canada was the leading recipient of U.S. exports, receiving 70% of total industrial sand and gravel exports; Mexico received 17%, and Japan, 5%. The remainder went to many other countries. The average unit value of exports increased to $119.12 per ton in 2013 from $75.15 per ton in 2012. In 2013, export unit values varied widely by region; exports of silica sand to Asia averaged $436.48 per ton, and exports to the rest of the world averaged $99.75 per ton.

Imports for consumption of industrial sand and gravel decreased by 48% to 160,000 t, compared with those of 2012 (table 9). Canada supplied about 89% of the silica sand imports, and imports from Canada averaged $16.48 per ton; this included cost, insurance, and freight costs to the U.S. port of entry. The total value of imports was $11.7 million, with an average unit value of $73.20 per ton. Higher priced imports came from Australia, Chile, China, Germany, Japan, Mexico, and the Netherlands.

World Review.—Based on information provided mainly by foreign governments, world production of industrial sand and gravel was estimated to be 142 Mt (table 10). Of the countries listed, the United States was the leading producer followed, in descending order, by Italy, France, Turkey, Germany, United Kingdom, Mexico, Moldova, India, Spain, and Australia. 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 sometimes difficult. In addition to the countries listed, many other countries were thought to have had some type of silica production and consumption.

Outlook.—The United States is the leading producer and a major consumer of silica sand and is self-sufficient in this mined mineral 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 is also produced in Arkansas, Missouri, Oklahoma, and Texas. Domestic production is expected to continue to meet 97% to 98% of U.S. demand well beyond 2013. Barring future declines in the overall U.S. economy, imports of silica sand from Canada and Mexico, and higher valued material from China are expected to slowly increase. U.S. consumption of industrial sand and gravel in 2014 was expected to be 70 to 75 Mt.

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 will continue to be an important factor in determining the economic feasibility of developing a deposit. 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 reduce demand for foundry and glass sand. These substitutes, which are mainly ceramics and polymers, would likely increase the demand for ground silica sand, which is used as a filler in plastics; glass fibers, which are used in reinforced plastics; and silica sand (chemical, ground, or whole-grain), which is used as a raw material for ceramics. Increased efforts to reduce waste and to increase recycling also would be likely to lower the demand for mined glass sand. Glass cullet is an industry term for furnace-ready scrap glass and is an important material used in the manufacturing of glass. 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 decrease by approximately 2% to 3%. In 2012, 41% of beer and soft drink glass bottles were recovered for recycling. An additional 34% of wine and liquor glass bottles and 15% of food and other glass jars were recycled. In total, about 34% of all glass containers were recycled (Glass Packaging Institute, 2013). Based on these factors, production of silica sand for glassmaking in 2014 was expected to be 8 to 9 Mt.

The demand for foundry sand is dependent mainly on automobile and light truck production. Production and sales of automobiles and light trucks increased in 2013 and the trend continued into 2014. 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 sand as foundry sand, but these other "sands" usually suffer from a severe price disadvantage. Based on these factors, production of silica foundry sand in 2014 was expected to be 4.2 to 4.5 Mt (Statista, 2015).

Frac sand sales increased dramatically in 2013 compared with those in 2012. Production of crude oil and natural gas increased in the United States in 2013 with the trend continuing into 2014. On average, crude oil and natural gas prices declined slightly in 2013 with an overall trend of fluctuating prices into 2014. Based on this trend, increasing demand for and production of frac sand should be sustained in 2014. Myriad factors affect the demand for frac sand, such as fluctuating prices for natural gas as dictated by seasonal weather conditions. Hydrocarbon drilling and production efficiency, coupled with improved hydraulic fracturing techniques that require more frac sand volume use per well, could tend to increase demand for frac sand to accommodate shorter, larger fractures. Furthermore, higher volumes of frac sand of smaller grain size to fill fractures were in high demand for slickwater fracturing (adding small amounts of chemicals to increase fluid flow) of unconventional horizontal natural gas wells. Conversely, frac sand of coarser grain size was in demand for reservoirs where petroleum was sought as opposed to natural gas. Coarser grain size increases fluid conductivity in petroleum wells (Industrial Minerals, 2013c). Additionally, frac sand has a lower unit cost when compared with other proppants. Based on available information, production of frac sand is expected to be 50 to 54 Mt in 2014.

Health concerns about the use of silica sand 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, 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

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. Historically, it is synthetically produced from natural feedstock quartz, termed lascas, which is mined. However, cultured quartz crystal that has been rejected owing to crystallographic imperfections is used by certain companies as feedstock for growing cultured quartz crystal. 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.

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, 2013, 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 individual crystals in the NDS inventory that weigh 10 kg or more and 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. Brazil traditionally has been the source of such large natural crystals, but changes in mining operations have reduced output.

No natural quartz crystal was sold from the NDS in 2013, and the Federal Government did not intend to dispose of or sell any of the remaining material.

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 2013, based on the USGS survey, no domestic companies reported the production of cultured quartz crystal. However, cultured quartz crystal production existed in the United States, but production statistics were not available. Two companies produced cultured quartz crystal in the United States. Cultured quartz crystal was produced overseas, primarily in Asia and Europe.

Consumption.—Total U.S. consumption of quartz crystal in 2013 was estimated at 1,600 kilograms. 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.

Prices.—The price of as-grown cultured quartz was estimated to be $200 per kilogram in 2013. Lumbered quartz, which is as-grown cultured quartz that has been processed by sawing and grinding, was estimated to be $400 per kilogram in 2013, however, prices ranged from $20 per kilogram to more than $900 per kilogram, 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 were predominantly fused mullite and fused zirconia, which were inadvertently reported as quartz crystal, not including mounted piezoelectric crystals. Although no definitive data exist listing import sources for cultured quartz crystal, imported material was thought to be mostly from China, Japan, Romania, and the United Kingdom.

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, Romania, 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.—Demand for cultured quartz crystal for frequency-control oscillators and frequency filters in a variety of electronic devices should remain stable. However, over the past several years silicon has gradually replaced cultured quartz in two very important markets—cellular telephones and automotive stability control applications. Future capacity increases to grow cultured quartz crystal may be negatively affected by this development. Growth of the consumer electronics market (for example, personal computers, electronic games, and tablet computers) is likely to sustain global production of cultured quartz crystal.

Special Silica Stone Products

It was estimated that in 2013, crude production of special silica stone decreased by 6%, compared with that of 2012 (table 1). The value of production in 2013 was $36,000—an 8% decrease from 2012. 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 chapters in the USGS Minerals Yearbook, volume I, Metals and minerals).

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 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 to Washita stone, a soft coarse 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 2013, the average value of crude material suitable for cutting into finished products was estimated to be $247 per metric ton.

Foreign Trade.—In 2013, silica stone product exports had a value of $10.9 million, down by 8% from that in 2012. 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 2013.

In 2013, the value of imported silica stone products was $11.9 million, up by 6% from that in 2012. These imports were hand sharpening or polishing stones, which accounted for most of or all the imported silica stone products in 2013. 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 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 2013, three U.S. firms were known to produce and process tripoli. American Tripoli, Inc. operated a mine and produced finished material in Newton County, MO. Malvern Minerals Co. in Garland County, AR, produced crude and finished material from novaculite. Unimin Specialty Minerals Inc. in Alexander County, IL, produced crude and finished material. Of the three U.S. firms, two responded to the USGS survey. Production for the nonrespondent was estimated based on reports from previous years and supplemented with worker-hour reports from MSHA.

Consumption.—It was estimated that sales of processed tripoli in 2013 decreased by 9% in quantity to 110,000 t with a value of $17.6 million (table 1). The decrease in tripoli sales was owing to lessened demand for its use as an abrasive and as a functional filler and extender in adhesives, plastics, rubber, and sealants. Tripoli was mostly used as a filler and extender in enamel, caulking compounds, linings, paint, plastic, rubber, and other products. In 2013, the primary use of tripoli (95%) was as a filler and extender. Less than 1% of the tripoli was used in brake-friction products and refractories. The end-use pattern for tripoli has changed significantly in the past 43 years. In 1970, nearly 70% of the processed tripoli was used as an abrasive. In 2013, less than 5% of tripoli output was used as an abrasive.

Prices.—The average unit value as reported by domestic producers of all tripoli sold or used in the United States was estimated to be $161 per metric ton in 2013. The average unit value of abrasive-grade tripoli sold or used in the United States during 2013 was estimated to be $280 per metric ton, and the average unit value of filler-grade tripoli sold or used domestically was estimated to be $157 per metric 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 being created is low.

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TABLE 1
SALIENT U.S. SILICA STATISTICS[1]

(Thousand metric tons and thousand dollars unless otherwise specified)

		2009	2010	2011	2012	2013
Industrial sand and gravel:[2]						
Sold or used:						
Quantity:						
Sand		26,900	31,700	43,400	50,300	61,900
Gravel		565	582	348	345	276
Total		27,500	32,300	43,800	50,600 r	62,100
Value:						
Sand		921,000	1,130,000	1,990,000	2,670,000	3,460,000
Gravel		21,000	14,900	14,400	8,880	9,350
Total		942,000	1,150,000	2,000,000	2,670,000	3,470,000
Exports:						
Quantity		2,150	3,950	4,330	4,360	2,960
Value		175,000	323,000	371,000	327,000	352,000
Imports for consumption:						
Quantity		95	132	316	306	160
Value		8,080	19,300	87,900	36,600	11,700
Processed tripoli:[3]						
Quantity	metric tons	79,700	110,000	73,700	120,000	110,000
Value		16,400	20,000	16,500	18,900	17,600
Special silica stone:						
Crude production:						
Quantity	metric tons	W	W	W	160 e	150 e
Value		W	W	W	39 e	36 e
Sold or used:						
Quantity	metric tons	W	W	W	500 e	470 e
Value		W	W	W	820 e	770 e

eEstimated. rRevised. W Withheld to avoid disclosing company proprietary data.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Excludes Puerto Rico.
[3]Includes amorphous silica and Pennsylvania rottenstone.

TABLE 2
INDUSTRIAL SAND AND GRAVEL SOLD OR USED IN THE UNITED STATES, BY GEOGRAPHIC DIVISION[1]

	2012				2013			
Geographic region[2]	Quantity (thousand metric tons)	Percent of total	Value (thousands)	Percent of total	Quantity (thousand metric tons)	Percent of total	Value (thousands)	Percent of total
Northeast:								
New England	133	(3)	$6,600	(3)	141	(3)	$7,310	(3)
Middle Atlantic	1,360	3	62,500	2	1,550	2	62,800	2
Midwest:								
East North Central	20,900	41	1,210,000	47	32,200	52	1,830,000	53
West North Central	7,470	15	422,000	16	8,600	14	576,000	16
South:								
South Atlantic	3,650 r	7	113,000 r	4	3,840	6	144,000	4
East South Central	1,440	3	39,800	2	1,560	3	57,500	2
West South Central	13,200	26	701,000	24	12,000	19	693,000	20
West:								
Mountain	1,200	2	66,900	3	1,040	2	44,500	1
Pacific	1,350	3	49,400	2	1,220	2	55,300	2
Total	50,600 r	100	2,670,000	100	62,100	100	3,470,000	100

rRevised.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Sales region equivalent to U.S. Census Bureau Geographic Division as follows: New England (CT, MA, ME, NH RI, VT); Middle Atlantic (NJ, NY, PA); East North Central (IL, IN, MI, OH, WI); West North Central (IA, KS, MN, MO, NE, ND, SD); South Atlantic (DC, DE, FL, GA, MD, NC, SC, VA, WV); East South Central (AL, KY, MS, TN); West South Central (AR, LA, OK, TX); Mountain (AZ, CO, ID, MT, NM, NV, UT, WY); Pacific (AK, CA, HI, OR, WA).
[3]Less than ½ unit.

TABLE 3
INDUSTRIAL SAND AND GRAVEL SOLD OR USED IN
THE UNITED STATES, BY STATE[1]

(Thousand metric tons and thousand dollars)

	2012		2013	
State	Quantity	Value	Quantity	Value
Alabama	401	13,200	334	14,900
Arizona	W	W	W	W
Arkansas	2,800	211,000	2,130	133,000
California	1,010	37,600	863	42,500
Colorado	W	W	W	W
Florida	195	5,800	200	10,300
Georgia	585	16,500	596	15,800
Illinois	7,440	504,000	9,850	501,000
Indiana	W	W	W	W
Iowa	W	W	W	W
Kentucky	--	--	W	W
Louisiana	512	21,800	709	36,200
Michigan	1,450	59,100	1,230	49,000
Minnesota	3,670	210,000	4,140	271,000
Missouri	1,390	76,000	1,990	127,000
Nebraska	W	W	W	W
Nevada	W	W	W	W
New Jersey	773	32,100	882	28,200
New York	W	W	W	W
North Carolina	1,230	30,400 r	1,290	30,700
North Dakota	W	W	W	W
Ohio	1,160	34,500	1,230	61,100
Oklahoma	2,850	112,000	2,120	89,100
Pennsylvania	W	W	W	W
Rhode Island	W	W	W	W
South Carolina	483	20,300	521	23,600
South Dakota	W	W	W	W
Tennessee	1,040	26,600	1,090	35,600
Texas	7,010	357,000	7,080	434,000
Virginia	W	W	W	W
Washington	W	W	W	W
West Virginia	312	16,000	429	21,900
Wisconsin	10,700	611,000 r	19,800	1,210,000
Other	5,630 r	279,000 r	5,690	329,000
Total	50,600 r	2,670,000	62,100	3,470,000

[r]Revised. W Withheld to avoid disclosing company proprietary data; included in "Other."
-- Zero.
[1]Data 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 2013, BY SIZE OF OPERATION[1]

Size range	Number of operations	Percent of total	Quantity (thousand metric tons)	Percent of total
Less than 25,000	31	17	282	(2)
25,000 to 49,999	16	9	502	(2)
50,000 to 99,999	23	13	1,430	2
100,000 to 199,999	34	19	4,540	8
200,000 to 299,999	8	4	1,690	3
300,000 to 399,999	15	8	4,550	7
400,000 to 499,999	7	4	2,860	5
500,000 to 599,999	5	3	2,480	4
600,000 to 699,999	6	3	3,480	6
700,000 and more	38	20	40,300	65
Total	183	100	62,100	100

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Less than ½ unit.

TABLE 5
NUMBER OF INDUSTRIAL SAND AND GRAVEL OPERATIONS AND PROCESSING PLANTS IN THE UNITED STATES IN 2013, BY GEOGRAPHIC DIVISION

Geographic region	Mining operations on land		Dredging operations	Total active operations
	Stationary	Stationary and portable		
Northeast:				
New England	1	--	--	1
Middle Atlantic	5	--	3	8
Midwest:				
East North Central	68	3	2	73
West North Central	14	2	3	19
South:				
South Atlantic	16	1	3	20
East South Central	7	--	3	10
West South Central	33	--	5	38
West:				
Mountain	4	--	--	4
Pacific	10	--	--	10
Total	158	6	19	183

-- Zero.

TABLE 6

INDUSTRIAL SAND AND GRAVEL SOLD OR USED BY U.S. PRODUCERS IN 2013, BY MAJOR END USE[1]

Major use	Northeast			Midwest			South			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)	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	$43.34	1,530	$47,000	$30.77	2,380	$84,100	$35.32	406	$20,000	$49.16	4,760	$170,000	$35.78
Flat, plate and window	150	$8,260	55.03	W	W	29.47	1,500	46,800	31.22	337	13,600	40.22	2,640	87,900	33.29
Specialty	115	6,350	55.22	168	9,590	57.07	137	5,670	41.36	W	W	64.50	426	22,000	51.62
Fiberglass, unground	W	W	10.87	W	W	45.39	W	W	39.88	W	W	40.00	294	11,500	39.20
Fiberglass, ground	--	--	--	(3)	1	--	406	22,500	55.50	W	W	57.50	413	23,000	55.68
Foundry:															
Molding and core, unground	41	1,690	41.32	3,770	158,000	41.88	467	21,700	46.52	39	2,050	52.49	4,320	183,000	42.46
Molding and core, ground	--	--	--	13	698	53.69	12	866	72.17	--	--	--	25	1,560	62.56
Refractory	(3)	9	--	15	976	65.07	77	3,380	43.90	--	--	--	93	4,370	46.94
Metallurgical, flux for metal smelting	--	--	--	--	--	--	W	W	49.17	W	W	10.43	W	W	33.58
Abrasives:															
Blasting	49	2,830	57.65	23	1,500	65.09	267	12,600	47.24	W	W	15.60	427	18,300	42.84
Chemicals, ground and unground	3	146	48.67	628	29,200	46.45	509	26,700	52.42	7	324	46.29	1,150	56,300	49.11
Fillers, ground, rubber, paints, putty, etc.	3	130	43.33	W	W	50.69	W	W	50.65	W	W	58.20	364	18,500	50.73
Whole-grain fillers/building products	217	7,970	36.71	392	16,800	42.87	616	27,000	43.90	486	25,000	51.43	1,710	76,800	44.89
Ceramic, ground, pottery, brick, tile, etc.	W	W	51.68	10	596	59.60	W	W	52.43	W	W	48.00	138	7,260	52.58
Filtration:															
Water, municipal, county, local	38	2,140	56.18	111	6,400	57.61	86	5,310	61.79	9	607	67.44	244	14,500	59.23
Swimming pool, other	9	462	51.33	19	939	49.42	50	1,950	39.08	W	W	67.00	79	3,420	43.32
Petroleum industry:															
Hydraulic fracturing	--	--	--	32,000	2,060,000	64.25	8,490	541,000	63.82	331	20,800	62.93	40,900	2,620,000	64.15
Well packing and cementing	371	11,000	29.70	222	12,400	55.68	103	6,790	65.91	19	1,480	77.89	715	31,600	44.26
Recreational:															
Golf course, greens and traps	61	1,690	27.69	57	2,670	46.77	273	6,490	23.79	21	1,090	52.10	412	11,900	28.99
Baseball, volleyball, play sand, beaches	14	455	32.50	178	7,050	39.60	89	2,850	32.03	14	810	57.86	295	11,200	37.84
Traction, engine	6	245	40.83	26	624	24.00	33	958	29.03	W	W	51.50	74	2,340	31.66
Roofing granules and fillers	W	W	40.14	73	1,740	23.82	334	8,070	24.16	W	W	51.50	449	11,700	26.10
Other, ground silica	W	W	56.25	391	17,100	17.93	215	11,000	47.79	W	W	40.00	116	3,000	25.82
Other, whole grain	572	25,400	11.99	1,030	26,500	19.31	1,220	52,900	30.73	592	13,900	15.52	1,900	64,100	23.21
Total or average	1,650	68,800	41.72	40,700	2,400,000	58.93	17,300	889,000	51.52	2,260	99,600	44.04	61,900	3,460,000	55.86
Gravel:															
Silicon, ferrosilicon	--	--	--	--	--	--	W	W	23.13	W	W	58.00	130	3,120	24.02
Filtration	W	W	80.75	W	W	39.56	W	W	22.88	--	--	--	25	1,190	47.40
Other uses, specified	W	W	W	W	W	W	40	2,170	W	W	W	W	121	5,040	41.65
Total or average	39	1,270	32.44	58	2,590	44.57	173	5,250	30.32	5	250	50.00	276	9,350	33.86
Grand total or average	1,690	70,100	41.51	40,800	2,400,000	58.91	17,400	894,000	51.31	2,270	99,800	44.06	62,100	3,470,000	55.76

W Withheld to avoid disclosing company proprietary data; for sand, included in “Other, whole grain”; for gravel, included in “Total or average.” -- Zero.

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

[2]Calculated using unrounded data.

[3]Less than ½ unit.

TABLE 7

INDUSTRIAL SAND AND GRAVEL SOLD OR USED, BY DESTINATION[1]

(Thousand metric tons)

Destination	2012	2013	Destination	2012	2013
State:			State—Continued:		
Alabama	270	207	New Jersey	400	418
Alaska	W	W	New Mexico	W	W
Arizona	12	8	New York	W	W
Arkansas	765	653	North Carolina	811	823
California	1,060	796	North Dakota	504	437
Colorado	W	W	Ohio	316	1,730
Connecticut	W	W	Oklahoma	1,620	1,280
Delaware	W	W	Oregon	W	W
District of Columbia	W	W	Pennsylvania	1,090	2,630
Florida	275	338	Rhode Island	W	W
Georgia	W	W	South Carolina	175	186
Hawaii	W	W	South Dakota	35 r	33
Idaho	W	W	Tennessee	577	563
Illinois	1,620	847	Texas	7,150	9,590
Indiana	W	W	Utah	W	W
Iowa	W	W	Vermont	W	W
Kansas	155	144	Virginia	W	W
Kentucky	W	W	Washington	W	W
Louisiana	270	259	West Virginia	W	W
Maine	W	W	Wisconsin	2,520	3,440
Maryland	W	W	Wyoming	W	W
Massachusetts	W	W	Countries:		
Michigan	399	266	Canada	W	W
Minnesota	345	212	Mexico	405	175
Mississippi	W	W	Other	W	W
Missouri	165	152	Other:		
Montana	12	13	Puerto Rico	W	W
Nebraska	W	W	U.S. possessions and territories	W	W
Nevada	W	W	Destination unknown	25,200	29,200
New Hampshire	W	W	Total	50,600 r	62,100

[r]Revised. W Withheld to avoid disclosing company proprietary data; included in "Total."

[1]Data 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 COUNTRY[1]

(Thousand metric tons and thousand dollars)

Destination	2012 Quantity	2012 Value[2]	2013 Quantity	2013 Value[2]
Africa and the Middle East:				
Egypt	--	--	(3)	5
Israel	(3)	267	2	407
Other	3	1,680	4	1,520
Total	3	1,950	6	1,930
Asia:				
China	30	58,800	17	35,700
Hong Kong	(3)	215	1	381
Japan	632	29,600	142	27,700
Korea, Republic of	6	4,360	4	4,830
Singapore	1	526	1	710
Taiwan	2	1,810	2	2,100
Other	4	3,010 r	3	2,790
Total	675	98,400	170	74,200
Europe:				
Belgium	175	6,060	47	7,790
Germany	150	28,600	32	26,300
Italy	(3)	85	(3)	280
Netherlands	11	6,130	14	7,530
Russia	(3)	7	(3)	37
United Kingdom	2	1,550	2	1,550
Other	135	8,660 r	40	7,290
Total	473	51,100	135	50,700
North America:				
Bahamas, The	1	178	3	577
Canada	2,330	116,000	2,060	174,000
Mexico	807	45,100	504	34,800
Trinidad and Tobago	1	277	2	903
Other	8	1,670	7	1,740
Total	3,140	163,000	2,580	212,000
Oceania:				
Australia	1	324	1	462
New Zealand	--	126	3	514
Total	1	450	4	976
South America:				
Argentina	25	5,150	56	8,370
Brazil	13	1,510	2	1,820
Colombia	6	994	2	395
Peru	15	3,680	4	951
Venezuela	1	418	(3)	151
Other	1	586	1	606
Total	61	12,300	65	12,300
Grand total	4,360	327,000	2,960	352,000

[r]Revised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Free alongside ship value of material at U.S. port of export. Based on transaction price; includes all charges incurred in placing material alongside ship.
[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9
U.S. IMPORTS FOR CONSUMPTION OF INDUSTRIAL SAND, BY COUNTRY[1]

(Thousand metric tons and thousand dollars)

Country	2012		2013	
	Quantity	Value[2]	Quantity	Value[2]
Australia	1	741	2	2,170
Canada	226	8,100	142	2,340
Chile	1	294	(3)	21
China	3	557	(3)	324
Germany	(3)	586	(3)	299
Japan	(3)	7	(3)	60
Mexico	64	23,400	8	2,520
Netherlands	(3)	58	(3)	3
Other	11	2,810 r	8	3,990
Total	306	36,600	160	11,700

[r]Revised.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Cost, 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.
[3]Less 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]	2009	2010	2011	2012	2013[e]
Algeria[e]	134 [4]	95 [4]	95	95	100
Argentina	364	531	517	615 [r]	500
Australia[e]	4,000 [r]	3,100 [r]	3,500 [r]	3,500 [r]	3,000
Austria	1,200	939	898	820 [r]	808
Belize	-- [r]	-- [r]	-- [r]	-- [r]	--
Bosnia and Herzegovina	525	228 [r]	119 [r]	121 [r]	114 [4]
Brazil, silex	NA [r]	NA [r]	NA [r]	NA [r]	NA
Bulgaria[e]	657 [4]	660	660	660	660
Canada, quartz	1,296	1,171	1,431 [r]	1,593	1,690
Chile	1,405	1,326	1,237	1,267	1,358 [4]
Croatia	278	241	227	106 [r]	102 [4]
Cuba	16	11	20 [r]	25 [r]	26
Czech Republic, foundry and glass sand	1,364	1,361	1,371	1,340 [e]	1,274 [4]
Ecuador	6 [r]	6 [r]	27 [r]	30 [r, e]	30
Egypt[e, 5]	410 [4]	401 [4]	400	400	400
Eritrea	-- [r]	-- [r]	-- [r]	-- [r]	--
Estonia, industrial sand	33 [r]	36 [r]	14 [r]	21 [r]	20
Ethiopia[e, 6]	31 [4]	70 [4]	7 [r]	7 [r]	33
Finland[e]	2,241 [4]	267 [r]	312 [r]	257 [r]	260
France	7,442	8,498	6,286	8,880 [r]	8,752 [4]
French Guiana	-- [r]	-- [r]	-- [r]	-- [r]	--
Gambia	1,062	1,121	-- [r]	-- [r]	--
Germany	6,453	7,234	7,770	7,498	7,500
Greece	38	40 [e]	2 [r]	NA [r]	NA
Guatemala	36	62	60 [e]	49	53 [4]
Guyana[7]	-- [r]	-- [r]	-- [r]	-- [r]	--
Hungary, foundry and glass sand	85	271	287 [r]	124 [r]	145
Iceland	-- [r]	-- [r]	-- [r]	-- [r]	--
India	2,619 [r]	3,172 [r]	4,496 [r]	3,985 [r]	3,432 [4]
Indonesia[e]	32 [4]	36	37	38	35
Iraq	18	(8) [r]	(8) [r]	1 [r]	2
Israel	163	198	233	180 [r, e]	200
Italy	19,759	17,656	16,369	13,946 [r]	13,870 [4]
Jamaica	7	13	14 [r]	14 [r]	16 [4]
Japan	2,856	3,078	3,003	2,877 [r]	3,000
Jordan	298	150 [r]	88	88 [r, e]	90
Kenya[e]	15	16 [r]	17 [r]	18	19
Korea, Republic of	4 [r]	4 [r]	4 [r]	4 [r]	4
Latvia	NA [r]	NA [r]	NA [r]	NA [r]	NA
Lithuania	41	67	53	54 [r]	57 [4]
Malaysia	630	932	1,340	932 [r]	1,244 [4]
Mexico	2,484	2,608	2,542 [r]	3,593	3,590
Moldova	1,830	2,146	2,547	3,042 [r]	3,502 [4]
New Zealand	43	113	109	73 [r]	102 [4]
Nigeria[e]	32 [4]	30	30	30	30
Norway, quartz and quartzite	1,022	1,055	1,162 [r]	1,083 [r]	1,000
Peru, quartz and quartzite (crushed)[e]	124	124	124	87 [r, 4]	88
Philippines	284	296	352	260 [r, e]	429
Poland	1,793 [r]	1,995 [r]	2,290 [r]	2,149 [r]	2,112 [4]
Portugal, quartz and quartzite	35	76	84 [r]	80 [r, e]	37
Saudi Arabia	709	820	1,303 [r]	1,368 [r]	1,300
Slovakia[e]	620 [r, 4]	620 [r]	600 [r]	600 [r]	600
Slovenia	327	254 [r]	231 [r]	219 [r]	224 [4]
South Africa	2,306	2,905	2,863	2,150 [r]	2,107 [4]
Spain, industrial sand	4,965 [r]	5,057 [r]	5,073 [r]	3,416 [r]	3,400
Sri Lanka[e]	30 [r, 4]	34 [r, 4]	36 [r]	37 [r]	38
Sweden, quartz and quartzite[e]	56	85 [4]	163 [r]	101 [r]	102 [4]

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]	2009	2010	2011	2012	2013[e]
Taiwan	328	306	173	58 [r]	62 [4]
Thailand[e]	500 [4]	500	500	500	500
Turkey	4,499	4,022	7,021	7,085 [r]	7,969 [4]
United Kingdom	3,755	4,070 [r]	3,969 [r]	3,888 [r]	4,000
United States, sold or used by producers	27,500	32,300	43,800	50,600 [r]	62,100 [4]
Venezuela	674 [r]	459 [r]	500 [e]	118 [r]	8 [4]
Total	109,000 [r]	113,000 [r]	126,000 [r]	130,000 [r]	142,000

[e]Estimated. [r]Revised. NA Not available. -- Zero.

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

[2]Includes data available through March 31, 2015.

[3]In addition to the countries listed, Angola, Antigua and Barbuda, The Bahamas, Belgium, Denmark, Iran, Ireland, the Netherlands, Paraguay, and Romania produce industrial sand, but current available information is inadequate to formulate reliable estimates of output levels. Based on estimates of glass end use consumption. China is the world's largest producer of industrial sand; however, available information is inadequate to formulate reliable estimate of output levels.

[4]Reported figure.

[5]Fiscal year beginning July 1 of that stated. Silica sand only; no gravel.

[6]Ethiopian calendar year ending July 7 of that stated.

[7]Source: Guyana Geology and Mines Commission and the Bank of Guyana.

[8]Less than ½ unit.