INDUSTRIAL SAND AND GRAVEL

By Wallace P. Bolen

Industrial sand and gravel production, consumption, and imports increased in 1995 compared with 1994. Silica exports of 1.8 million metric tons were unchanged from 1994. Industrial sand and gravel, often termed "silica," "silica sand," and "quartz sand," includes high SiO_2 content sands and gravels. These sands are used in glassmaking, for foundry, abrasive, and hydraulic fracturing applications, and many other uses. The specifications for each use varies but silica resources for most markets are abundant. Leading producing States were Illinois, Michigan, New Jersey, California., Wisconsin., and Texas. In almost all cases, silica mining employs open pit mining methods with standard mining equipment. Sand and gravel mining, in the vast majority of cases, has little environmental impact except for temporarily disturbing the immediate environment while mining operations are active.

Production of industrial sand and gravel in 1995 increased to 28.2 million metric tons, about 3% more than 1994's production. This 3% increase represents a decrease in growth for the industry which had a 6% increase from 1993 to 1994. Production increased in response to greater demand for many uses including: blast, filtration, and traction sand; fiber, flat, and specialty glass sand; for silica used in chemicals and as filler; and in the "whole grain filler/building products" category.

Exports of silica sand and gravel, valued near $700 million, were virtually unchanged from 1994. Imports of industrial sand and gravel more than doubled from 1994, but were still much smaller than exports, about 65,000 tons. Domestic apparent consumption of industrial sand and gravel in 1995 was 26.4 million tons, an increase of about 4% compared with that of 1994. *(See table 1.)*

Legislation and Government Programs

The regulation of respirable silica continued to concern miners and consumers of many minerals that contain crystalline silica, especially the industrial sand and gravel industry. Regulatory Government agencies, including the Occupational Safety and Health Administration, the Mine Safety and Health Administration, and the Environmental Protection Agency, (EPA) continued to study, or planned to further study, silica related health concerns. Crystalline silica and safety concerns were addressed in an article in "Ceramic Industry," April 1995[1]. The article also discussed manmade fibers which are also being reviewed for health concerns. These fibers included refractory ceramic fibers and fiberglass. Additionally, the EPA also proposed an expansion of the Toxic Release Inventory to cover mineral production, including silica and quartz crystals.

The abrasive blast industry has already lost market share as California, Louisiana, Ohio, Utah, the Port of Houston, and the U.S. Navy have banned sandblast products with more than 1% silica. In one response to the continuing regulation of crystalline silica, the California Mining Association sent a letter to the Governor outlining issues that have a potential for impacts on the State economy.[2]

In a final resolution of an issue reviewed in this report in previous years, the Governments of Japan and the United States reached an agreement to open the Japanese market to U.S. flat glass. The market share for U.S. flat glass in Japan has been less than 1%.[3]

Production

Domestic production data for industrial sand and gravel were developed by the U.S. Geological Survey (USGS) from one voluntary survey of U.S. producers. Of the 161 industrial sand and gravel operations surveyed, 101 (63%) reported to the USGS. Their combined production represented about 64% of the U.S. total published in table 1. The production of nonrespondents was estimated based on previously reported information and other factors. Of the 161 operations, 144 (89%) were active and 17 idle.

The Midwest (East and West North Central regions) continued to lead the Nation in production with about 44% of the 28.2 million metric tons produced in the United States, followed by the South (South Atlantic, East and West South Central regions) with about 34% and the West (Pacific and Mountain regions) with 13%. *(See table 2 and figure 1.)*

The six leading States in the production of industrial sand and gravel, in descending order of volume, were Illinois, Michigan, New Jersey, California, Wisconsin, and Texas. Their combined production represented 50% of the national total. Notable production changes occurred in New Jersey which experienced a 4% increase in production, and Michigan, which had a 3% decrease compared with 1994. California had a slight decrease in production while Illinois, Wisconsin, and Texas were virtually unchanged from 1994 to 1995. Highlighted production changes in other States included: Alabama, down over 20%; Missouri, down 6%; North Carolina, down 9%;Georgia up 30%; Louisiana, up 26%; South Carolina, up 20%; and Tennessee, up 40%. *(See tables 3.)*

The USGS canvassed 79 producers of industrial sand and gravel with 144 active operations. About 78% of the industrial sand and gravel was produced by 51 operations, each with an annual production of more than 200,000 tons. The 10 leading producers of industrial sand and gravel were, in descending order of tonnage, Unimin Corp., U.S. Silica Co., Fairmount Minerals Ltd., Oglebay Norton Co., The Morie Co., Inc., Badger Mining Corp., Construction Aggregates Corp., Simplot

Industries Inc., Nugent Sand Co. Inc., and Short Mountain Silica Co. Their combined production, from 58 operations, represented 72% of the U.S. total. *(See tables 4 and 5.)*

Merger and acquisition activity increased in 1994 and continued in 1995. On January 4, 1995, Martin Marietta Aggregates, Raleigh, NC, bought out Dravo Corp.'s construction aggregates business. Although mainly a construction sand and gravel producer, with 22 production facilities in 9 States and the Bahamas, Dravo also produced the higher grades of silica sand and gravel in Alabama.

The biggest news of 1995 came early in the year when it was confirmed that U.S. Borax, a subsidiary of Rio Tinto Zinc Plc., planned to divest of U.S. Silica. Late in 1995, D. George Harris & Associates, a New York City-based industrial management and advisory firm, announced that it would buy U.S. Silica. Current management was to remain the same with D. George Harris as chairman of U.S. Silica. Because Harris is already a producer of soda ash, Harris hopes to become a major supplier to the glass industry. Additionally, the companies planned to upgrade facilities in order to increase filler-grade production and sales.

U.S. Silica's mines and plants in Ledyard, CT, and Elizabeth, IN, were finally closed down, with no production in 1995, after minimal sales and production in 1994.

Best Silica, part of Fairmount Minerals, purchased Southern Silica, Richmondale, Ross County, OH, on March 10, 1995. Coupled with the purchase of another Ohio-based operation in 1994, Fairmount continued to strenghthen its position as the third largest producer in the United States, with six active operations.

The Ashton Group, Tucson, AZ, a producer of silica flux, was added onto this survey starting this year.

Tuskegee Sand and Gravel, Inc., Tuskegee, AL, announced their shutdown, after being idle since September 30, 1994. Tuskegee was a producer of sand and gravel for both industrial and construction uses. Tuskegee was a producer of silica gravel for ferrosilicon and silicon metal production.

WHIBCO, Inc., reported their Wareham, Plymouth County, MA, plant closed down in 1995. It was unclear whether this plant would reopen. New England generally remains a difficult place to mine due to State and local regulations accompanied by a relatively small market. This is evident in the closures of this and U.S. Silica's operation in Connecticut.

Becker Minerals' Senter Field Plant, Lillington, Harnett County, NC, went out of business in 1995, after being idle in 1994.

And lastly, Sargent Sand Co. announced the closure of its operation at Ludington, Mason County, MI.

Consumption

Sand and gravel production reported by producers to the USGS was actually material used by the companies or sold to their customers. Stockpiled material was not reported until consumed or sold. Of the 28.2 million metric tons of industrial sand and gravel sold or used, 38% was consumed as glassmaking sand and 24% as foundry sand. Other important uses were frac sand (6%) and abrasive sand (6%). *(See table 6.)*

The production of industrial sand and gravel in the United States has developed in response to market location and vice versa as industry sometimes located near silica resources. Because silica deposits or resources are found throughout the United States, locating a consuming industry specifically to be near a silica source was not always a priority, although certainly a consideration. The auto industry, responding to iron, coal, clay, and silica resources, centered in the Midwest and thus foundry sands were exploited in Michigan, Ohio, Indiana, Illinois, and other regional States. This resulted in over 75% of the foundry sand being produced in the Midwestern region in 1995.

The glass industry, somewhat conversely, had to locate plants where they could minimize the shipping distance of finished glass products. Hence, glass plants were more evenly distributed as 40% of glass sand was produced in the Southern region, 31% in the Midwest, 16% in the West, and 13% in the Northeast, in 1995. To varying degrees, all silica production was similarly influenced as markets and consuming industries either forced the silica mining location or were forced to locate near the silica source.

The amount of sand sold for containers decreased 5% from 1994 levels, while the total shipments of glass containers dropped 6% during the year. The share of silica sold for all types of glassmaking as a percentage of all silica sold stayed at its 1994 level which was its lowest level since 1985 when glass markets consumed only 35% of silica sold. A worldwide survey of glass manufacturers revealed the following breakdown of glass sales by value: containers, 28%; consumer glassware, 21%; flat glass, 18%; lighting, 11%; other, 9%; fiberglass, 7%; video screens, 5%; and technical and laboratory, 1%.

Flat glass, unlike container glass, continued to be a good growth prospect for silica sales. As an indicator of this, Pittsburgh Plate and Glass Industries (PPG) Inc., has resumed operation of a second float glass line at its Mount Zion, IL, plant. The line will enable PPG to meet increasing demand for solar-control automotive glass products.[4]

Silica is used in ceramics in both whole grain and ground form. Generally the whole grain is used in the ceramic body, while the ground silica is used to decrease viscosity and expansion coefficent in ceramic glazes and other ceramic applications.

Silica was generally used in plastics as a filler, extender, and reinforcer. More specifically, it was used to thicken liquid systems, as a thixotropic agent, flatting agent, and was used to avoid plateout in polyvinyl chloride. As segregated for this survey, ground silica used as a filler was 178,000 tons, whole grain filler amounted to 1.37 million tons in 1995.

Specialty silicas were usually produced by means of chemical and thermal processing of natural silica, silicon metal, or as a byproduct of other mineral or chemical processing. Although the USGS did not specifically collect information for specialty silicas, their consumption does affect natural silica sales.

Specialty silicas and silanes (silica chemicals) included, but were not limited to, colloidal silicas, fumed silica, fused silica and quartz, precipitated silica, silica gels, silicones, and ultra-high-purity silica. These silicas were used in a variety of industries and products including abrasives, beverages, catalysts, coatings, electronics, encapsulants, food, health care, optics, paper and packaging, plastics, refractories, rubber, specialty coatings, textiles, water treatment, and many others. On table 6, industrial sand and gravel which would find its way into these specialty silicas is most likely reported in the categories "chemical" and "silicon metal." Silica sales for chemical production increased about 6% in 1995, compared with 1994. The main uses for silicon metal are in the manufacture of silanes, semiconductor-grade silicon, and in the production of aluminum alloys.

Sodium silicate, a prime silica chemical, has had increases in production for the last 4 years. Production of sodium silicate rose 8% between 1983-93 and demand grew 4% to 5% from 1993 to 1994. Consumption in the United States for 1992 totaled 980,000 tons and was divided into the following markets: pulp and paper, 41%; laundry detergent, 41%; derived silicas and silicates, 8%; and other, 10%. Sodium silicate is used as a raw material for such chemical derivatives as zeolites, fluid cracking catalyst, precipitated silicas, colloidal silica, and silica gel.

Rhône-Poulenc Basic Chemicals Co. has opened a 20,000-ton-per-year precipitated silica plant at Chicago Heights, IL. The facility will produce material for the rubber, dentifrice, and specialty chemical markets. The plant will also produce special abrasive grades of silicas. Rhône-Poulenc described the silica as a key component of new automobile tires that increase fuel efficiency by approximately 5%.[5]

PPG Industries has received approval to construct a second precipitated amorphous silicas plant at its Lake Charles, LA, facility. This new plant will add more than 30 million pounds annually of precipitated amorphous silica capacity.[6]

Semiconductor-grade silicon, a nearly pure silicon, is derived from specialty silicas and silicon metal, which are both produced from naturally occurring silica. Semiconductor sales in North America have grown rapidly over the last decade with the 1995 growth rate at 40%. Sales for 1995 were valued at $46.9 billion with projections for continued though slower growth.

Northeast.—Cumberland County, NJ, continued to be the largest source for the glass and foundry sand markets in the region. Unimin, U.S. Silica, and Morie, all of which operated plants in the county, were among the largest producers of sand for these markets. U.S. Silica's plant in Huntingdon County, PA, also produced significant amounts of sand for the glass market. Morie and Ricci Brothers Sand Co. Inc., both in Cumberland County, NJ, produced a major percentage of the abrasive blast sand in the region. WHIBCO's operation in Cumberland County, NJ, was also a large producer of foundry sand in the region.

Midwest.—Unimin's plants in La Salle and Ogle Counties, IL; Le Sueur and Scott Counties, MN; and Columbia County, WI, were among the leaders in producing sand for all four major markets: the blast, foundry, frac, and glass sand markets. Fairmount Minerals, with operations in Berrien and Van Buren Counties, MI, Geauga County, OH, and La Salle County, IL, was also a major producer of sand for the four major markets in the region. U.S. Silica's plant in La Salle County, IL, was a large producer for the glass, foundry, and frac markets and their St. Louis County, MO, operation was a large producer for the glass market. Construction Aggregates Corp., Ottawa County, MI; Nugent Sand Co. Inc., Muskegon County, MI; and Sargent Sand Co., Wexford County, MI, were all large producers for the foundry industry. Badger Mining, Jackson and Green Lake Counties, WI, was a major producer for the blast, foundry, and frac markets. Kaw Valley Sand and Gravel Co., Wyandotte County, KS, was a major producer of blast sand. Oglebay Norton's plants in Knox and Perry Counties, OH, were significant producers for the glass and blast markets.

South.—Unimin and U.S. Silica Co. were two of the largest producers of sand for the glass and foundry markets. Unimin's major plants were in Izard County, AR; Richmond County, NC; Pontotoc County, OK; and Frederick County, VA. U.S. Silica's Bullock County, AL; Johnston County, OK; Limestone County, TX; and Morgan County, WV, operations were their major contributors for these markets. Morie's Tuscaloosa County, AL; Marion County, GA; and Benton and Carrol Counties, TN, plants were large producers of foundry and glass sand. Cobb Industrial Corp., Red River Parish, LA; Foster-Dixiana Corp., Lexington County, SC; Huey Stockstill Inc., Pearl River County, MS; Mid-State Sand and Gravel Co., Allen and East Baton Rouge Parishes, LA; and Specialty Sand Co., Newton County, TX, were large producers of blasting sand. W. R. Bonsal and Co. and B. V. Hedrick Gravel and Sand Co., both in Anson County, NC, produced a large percentage of the industrial gravel used in the production of silicon and ferrosilicon. Oglebay Norton, with two operations in McCulloch County, TX, was the largest producer of frac sand, and an important contributor of blast sand for the region. WHIBCO in Kershaw County, SC, was an important producer of foundry sand. APAC Arkansas Inc., Crawford County, AR; Florida Rock Industries Inc., Putnam County, FL; and Short Mountain Silica Co., Hawkins County, TN, were important producers of glass sand. Montgomery Sand Co., Montgomery County, GA, was a large producer of blast sand for the region.

West.—Owens-Illinois, Simplot Industries, and Unimin were the three largest producers of glass sand in the region, with major operations in Amador County, CA; Clark County, NV; and Contra Costa County, CA, respectively. Lane Mountain Silica, Stevens County, WA; Lone Star Industries Inc., Monterey County, CA; and P. W. Gillibrand Co., Ventura County, CA; were the major suppliers for the sand blasting industry in the region. Simplot Industries, Clark County, NV, also supplied a large portion of the foundry sand consumed. FMC Corp., Power County, ID; Rhône-Poulenc Basic Chemicals Co., Beaverhead County, ID; and Monsanto Industrial Chemicals Co., Caribou County, ID, each produced industrial gravel for use as a flux in elemental phosphorus production. The Ashton Co., Pinal

County, AZ, was the largest producer of sand for metallurgical flux in the region.

Recycling of silica sands was limited to some foundry sands, particularly those used for making cores and molds with no-bake resin-bonded sands, some abrasive and airblasting sands, and, increasingly, post-consumer glass and scrap glass (cullet) that substitutes for batch mix (including industrial sand). Most glass recycling was restricted to container glass, with green and amber cullet consumed in greater amounts for glass production because it is more difficult to use cullet in flint batch mixes.

Glass container recycling was estimated at 37% in the United States for 1994, the sixth straight year of growth. This included glass used in glasphalt and those that were refilled, and represents an increase from the 1993 rate of 35%. The Freedonia Group projected a 4.7% annually increase in glass recycling.[7] The price for cullet varied based on region and grade [flint (clear), brown (amber), or green] and location. Cullet from consumers generally passes through a processor, who receives it from municipalities, counties, etc., and the processor then provides it to the glassmaker.

As the level of cullet used in glass production increases, so does the level of quality required. Contamination of cullet by ceramics and nonmagnetic materials was an increasing concern. Because of the increased use of recycled glasses, restrictions on the iron and chromium levels in glass sands have become stricter and the proportion of refractory particles allowed has been reduced to almost zero. The Fe_2O_3 content of a typical glass silica sand is now as low as 0.015% to 0.02% for flint glass manufacture and 0.1% to 0.15% for colored glass. Additionally, recycling of amber and green glass was substantially greater than flint glass and therefore lower grade deposits are in less demand.

Two reports were released concerning the continuing research into uses for post consumer glass. Terra-Green Technologies Inc. of Millersville, MD, has developed a tile line produced from >55% recycled glass.[8] The State of New York and Columbia University's School of Engineering and Applied Science have undertaken a study of "glascrete," which is a concrete made with glass in place of some or all of the aggregate. The study will include rigorous testing and will review the alkali-silica reaction problem that is common in traditional concrete.[9]

Besides glass, uses for spent foundry sound have also been researched. Italian equipment manufacturer Welko Industrial S.p.A. and Pennsylvania-based Vortec Corp. have developed a new ceramic tile which incorporates recycled industrial waste. Foundry sand was one of the many possible materials that could be included in this ceramic tile.[10]

Wedron Silica Co. (a subsidiary of Fairmount Minerals) and Systech Environmental Corp. have agreed to work together to provide recycling services in the industry. Nonhazardous materials, especially silica from foundry sands, will be placed at manufacturing plants for use as raw material substitutes in making portland cement and in other construction or paving applications.[11]

On the negative side, recycling of silica refractories is hardly ever done. Because recycling these refractories requires crushing and grinding, silica dust is generated. The dust must be controlled according to hazardous material regulations and this makes it prohibitively expensive to recycle.

International trends toward increased recycling of glass and foundry sands and innovative ideas on recycling other materials should influence greater recycling of silica products.

Transportation

Of the total industrial sand and gravel produced, 65% was transported by truck from the plant to the site of first sale or use, up from 61% in 1994; 32% was transported by rail, down from 36% in 1994; 2% by waterway; and 1% was not transported. Because most of the producers did not report shipping distances or cost per ton per mile, no transportation cost data were available.

Prices

Compared with that of 1994, the average value, freight-on-board (f.o.b.) plant, of U.S. industrial sand and gravel decreased slightly to $17.81 per metric ton. Average unit values for industrial sand and industrial gravel were $18.25 and $11.66 per ton, respectively. Nationally, ground industrial sand used as fillers for rubber, paint, and putty, etc., had the highest value per ton ($125.85), followed by silica for well packing and cementing ($69.24), ground silica for scouring cleansers ($68.00), ground silica sand used in ceramics ($44.10), ground sand used for fiberglass ($39.51), silica for swimming pool filters ($38.13), and frac sand ($33.67).

Industrial sand and gravel price changes were greatly mixed; some markets remained level, others had small increases or decreases, and still others experienced large increases or decreases. This situation was possible because although, the silica was essentially the same, most markets were very independent from each other and price competition was influenced by availability, regulatory and health concerns, and competition from other materials. Those end uses that sustained greater prices in 1995, compared with 1994, included: chemicals, container, flat, and specialty glass, fiberglass, frac, refractory, roofing granules and fillers, scouring cleansers, silicon carbide, traction, and well packing and cementing. Silica for blasting, ceramics, fillers, filtration, foundry, golf course, and silicon and ferrosilicon experienced a decrease in unit value.

The average value per ton of industrial sand and gravel was highest in the West ($19.29), followed by the South ($18.99), the Northeast ($17.91), and the Midwest ($16.42). Prices can vary greatly for similar grades of silica at different locations in the United States. For example, glass sand average value per ton varied markedly, from $20.06 in the West to $12.28 in the Midwest. Tighter supplies and higher production costs in the West and much greater competition in the Midwest, caused the difference in the cost of sand and gravel in these two regions. *(See table 6.)*

Foreign Trade

Exports of industrial sand were essentially unchanged from 1994, while the associated value increased 4%. Export distribution is as follows: 76% went to Canada, 7% went to Mexico, 8% went to Asia, 6.5% went to Europe, and the remainder went to the Middle East, Oceania, and South America.

Compared with those of 1994, imports for consumption of industrial sand increased 170% to 65,000 tons valued at $2.7 million. Silica imports vary greatly from year to year but are always rather insignificant. Australia supplied 95% of the silica imports for 1995, averaging about $25.50 per ton (including insurance and freight cost to the U.S. port). The Australian imports were the relatively low priced silica while higher priced silica came from Belgium, Canada, Germany, Japan, Sweden, and the United Kingdom. *(See tables 7 and 8.)*

World Review

World production of industrial sand and gravel, based on information usually provided by foreign Governments, was estimated to be 120 million metric tons, about the same as 1994. The United States. was the leading producer followed by, in descending order, the Netherlands, Germany, Austria, and France. Most countries in the world had some production and consumption of industrial sand and gravel because it is essential to the glass and foundry industries. However, because of the great variation in descriptions and usage for silica sand and gravel, it was difficult to get reliable information. Beyond those countries listed, several other countries were believed to have had some type of silica production and consumption. *(See table 9.)*

Current Research and Technology

Most of the research and process development reported in 1995 concerned silica chemicals but other important work continued involving glass and advanced materials.

OSi Specialties Inc., announced a new process that converts silicon metal directly into organofunctional silanes and will substantially reduce waste and other environmental concerns. The cost of the new process is said to be comparable to the more traditional process.[12]

In other silica-related research and development, Dow Corning Corp. has introduced a new family of resin modifiers in solid silicone powder form. Silicon powder resin modifiers are free flowing, 100% active silicone powders designed to enhance the physical properties of highly filled flame retardant thermoplastics, modify thermoplastic burning characteristics, and improve processing efficiency according to the company.[13] Dow Corning also reports the development of ozone-safe fluids for precision cleaning. The fluids are pure volatile methylsiloxane liquids which are exempt from Federal volatile organic compounds regulation, have a low surface tension, and exhibit mild solvent action during the cleaning process.[14]

Shin-Etsu Silicones of America Inc., formed in 1985 to supply the U.S. market with the Japanese parent company's line of silicone products, will open its own production facility in Akron, OH. The new facility will turn out room-temperature vulcanizing elastomers, gels, conformal coatings, adhesives, sealants, and other silicone products.[15]

In detergent development, Hoechst AG has agreed to supply almost all of the production of its new SKS-6 sodium silicate builder from its recently completed 50,000-ton-per-year plant at Knapsack, near Cologne, Germany, to Proctor and Gamble. The builder provides both water-softening properties and alkalinity, and does not require the addition of an alkaline. Additionally, Rhône-Poulenc introduced disilicate soda ash which the company claims reacts quickly at low temperatures.[16]

In glass developments, Ford Motor Co., in a collaborative design effort with key chemical suppliers, has unveiled an "all-fiber," glass-reinforced composite body design. The company says that the only metal used in the design is in the front-end engine framework.[17]

Researched continued on the use of glass to immobilize radioactive waste. Researchers at the U.S. Department of Energy's Savannah River Site have successfully vitrified samples of an intensely radioactive solution containing americium and curium.[18] The site has begun the final phase of a testing program aimed at immobilizing highly radioactive components contained in approximately 34 million gallons of liquid waste at the site.[19] As this process becomes better understood and accepted, the amount of silica used to form this glass should grow.

Research and development also continued in ceramics concerning silicon carbide (SiC) and silicon nitride (Si_3N_4). Kyocera Corp., Kyoto, Japan, announced it had developed a new manufacturing process which would enable silicon nitride engine components to be produced at a cost comparable to that for special steel parts.[20]

Outlook

The forecast range of total U.S. demand in the year 2000 is expected to be 26 to 30 million metric tons for industrial sand and gravel. Probable demand is expected to be about 29 million tons. All forecasts are based on previous performances for this commodity within various end uses, contingency factors considered relevant to the future of the commodity, and forecasts made by analysts and producers in the various markets.

Since 1987, annual demand for glass sand has fluctuated between 10.0 and 11.1 million tons. Shipments of glass containers were down 6% in 1995 from 1994 after falling from 1993 to 1994. In the United States, there were 137 billion container units consumed in 1985 and 20% were glass containers. By 1995, 182 billion units were consumed in the United States and the glass percentage had dropped to 14%. The amount of sand consumed for container glass has generally decreased since 1985 mainly because some glass containers were being replaced by aluminum cans and plastic containers and also because of an increase in recycled glass. Additionally,

many manufacturers were making the walls of glass containers thinner and this has lowered the amount of sand used. Glass container shipments were expected to be unchanged in 1996 from 1995.

In one note of good news for the container industry, Saint-Gobain's Containers Div. intends to build a $40-million facility for the manufacture of perfume bottles at Covington, GA, near Atlanta. The plant is scheduled to be operational by the end of 1996.[21]

Polyethylene terephthalate (PET) is the major plastic resin that is replacing glass in many container applications. Two firms announced they will expand their PET capacity, one will be a 272-million-kilogram per year plant in North America and the other is a 385-million-kilogram per year increase spread throughout plants in the United States and Canada. Since 1994, six companies have announced PET expansions in North America and this will increase the annual PET capacity by more than 1.36 billion kilograms which will more than double the pre-1994 capacity.[22]

For 1995, flat glass shipments fell 2.2% from 1994. This decrease coincided with drops in flat glass's primary markets: housing, down 7.4% and automobile production, down 6.1%. However, 1996 growth is predicted to be positive for flat glass shipments, within a range of 1% to 3%. Industry analysts predicted growth in residential and commericial construction with even better growth in auto industry production. Additionally, world flat glass demand is projected to increase by 5% annually through 1998.

Guardian Industries Corp. began construction of a $110 million float glass plant in DeWitt, IA, in May. This, their seventh float plant in the United States, is another indicator of growth for flat glass production and silica consumption.[23]

In another positive development, Mitsubishi Motors Corp. has announced plans to use automobile glass made by the U.S. firm Guardian Industries. Previously, Mitsubishi purchased the majority of its glass for passenger cars built domestically in the United States from Asahi Glass, a Japanese flat glass manufacturer.

Vetrotex CertainTeed, Valley Forge, PA, began a multimillion-dollar expansion project at its Wichita Falls, TX, fiberglass reinforcement manufacturing facility. The expansion will increase the company's total annual production volume by approximately 20%.[24] Schuller International Inc., Denver, CO, will invest $27 million in a fiberglass manufacturing machine for one of its Defiance, OH, facilities. The machine will add capacity for commercial and industrial board and blanket products, as well as specialty insulation for heating, ventilation, and air conditioning (HVAC) equipment, automotive and acoustic applications, and metal building insulation.[25] Additionally, Schuller announced that they will be adding up to 45,000 tons of capacity of continuous filament fiberglass throughout North America.

PPG Industries Inc. has announced plans to build a $50 million fiberglass manufacturing plant at Chester, SC. The facility will make reinforcement products for composites applications. The facility was to be operating in the spring of 1996 and have an annual capacity of about 23 to 27 million kilograms.[26] Owens-Corning is planning to expand capacity at its Jackson, TN, plant by bringing on a second line. The second line was scheduled to be fully operational in 1997 and will add 63 million kilograms, nearly doubling current production.[27]

Fiberglass production grew in 1995 and is expected to grow in 1996. Fiberglass plastic reinforcements were projected to have the strongest growth but paper and textile fiberglass were also supposed to see good growth in 1995. Insulation fiberglass production showed poor growth in 1995 and 1996 was not projected to be much better. Overall, fiberglass will likely grow about 3% per year through the year 2000.

In the specialty glass market, the fiberoptics market continued to grow and was expected to nearly triple to $14.5 billion by 1999. Competing with silica based fiberoptic material is plastic optical fiber. This plastic fiber is currently used in lighting, illumination, imaging, sensing, and security, but is not often used in communication-oriented applications.[28]

Corning Inc., Asahi Glass America, Inc., and Sony Electronics, Inc., have formed a partnership to produce television glass at Sony's manufacturing facility in Pittsburgh, PA. The facility will manufacture large-screen, rear-projection televisions and their 7-inch cathode ray tubes.[29]

Overall, although demand for fiber, flat, and specialty glasses is expected to increase, the largest tonnage consumer, the container segment, will likely experience negative growth. Therefore, demand for glass sand is expected to grow slowly in quantity through the year 2000. Probable demand for glass sand for the year 2000 is forecast to be 11.5 million tons, with a range of 9.5 to 12.5 million tons.

The use of foundry sand was dependent mainly on automobile and light-truck production. Toyota Motor Sales USA Inc. was expected to announce that it had chosen Evansville, IN, to be the site of its new $1 billion truck manufacturing facility. The plant will produce the T-100 pickup truck.[30]

Another important factor for the future consumption of virgin foundry sand was the recycling of used foundry sand. The level of recycling, though not clear, was thought to be increasing. Other materials or minerals compete with silica as foundry sand but these other "sands" usually suffer a severe price disadvantage. Based on these factors (mainly automotive-related foundry activity, competing materials, and recycling) the probable forecast for silica foundry sand consumption in the year 2000 was expected to be 7.0 million tons, and the demand range was expected to be 6 to 7.5 million tons.

Frac sand sales in 1995 were 4% lower than in 1994. The Baker-Hughes' cumulative drilling rig count comparing year-to-year data shows that 1995 stayed behind 1994's rig count throughout the year and ended the year 6% behind 1994's week by week comparison. The lower rig activity in 1995 coincides with the lower frac sand sales. As has been the case when comparing oil and gas drilling, U.S. production of oil will likely suffer as imports continue to control a higher percentage of supply but natural gas production will likely maintain steady increases. Exports were an important market for frac sand as

U.S. sand was shipped to locations throughout the world.

Based on these factors, demand is expected to grow slowly for this end use during the decade. Growth will be in response to strong exports and growing demand for natural gas but tempered by limited U.S. oil well demand. Probable demand for hydraulic fracturing sand for the year 2000 is expected to be 1.7 million tons, with a range of 1.5 to 1.8 million tons.

Semiconductor use is also important to the silica industry. Samsung Electronics, a South Korean company, will invest $3 billion to construct computer chip plants in Germany, Malaysia, and the United States. Samsung plans to begin construction in the United States first and will build the world's largest semiconductor plant in Austin, TX, with an investment of $1.5 billion. The plant will begin mass production of 6 million 16-megabit dynamic random access memory (DRAM) unit's per month in 1997.[31]

Additionally, Intel Corp., the Santa Clara, CA-based semiconductor giant, chose to locate a $1.4 billion chip fabrication plant in Phoenix, AZ.[32] Also in Phoenix, AZ, Sumitomo Sitix Corp. announced that it will build a $400-million silicon wafer manufacturing facility.[33]

It is obvious, based on the substantial number of citations in this report, that specialty silicas will continue to see sustained growth through at least the year 2000. Cabot Corp. has signed a letter of intent to build a $50-million fumed silica plant in Midland, MI, on site of the Dow Corning Corp. facility there. Cabot expects to start commercial production in the first quarter of 1999 from a facility with capacity for 7 million kilograms per year of fumed silica.[34]

General Electric (GE) Silicones is planning a $48-million expansion of its silicone facility in Waterford, NY. The investment will increase by 22% the plant's capacity to produce siloxane, the key building block for all silicone products made at the site and around the world. Adjacent to Waterford is a Degussa Corp. facility producing fumed silica. Degussa takes silane raw materials from GE, converts them to fused silica and then send some back to GE for use in silicone products. Degussa is looking to add additional silica capacity by 1997 or 1998, either at Waterford or Mobile, AL.[35] Also, Degussa is going ahead with a 13.6-million-kilogram expansion of its Chester, PA, silica plant. It will start mid-1997 and bring capacity to 32 million kilograms per year.[36]

Assuming that the silica route will be through the chemical and silicon metal categories, it is expected that the chemical and silicon metal categories should see better than average growth, probably in the 2% to 4% annual growth range. This positive forecast would be tempered if the specialty silicas producers are using a silica source other than industrial sand and gravel. The process for each type of silica is highly variable and certainly not well advertised; therefore, it is difficult to determine the natural source and the processing route for the silica or silicate. Kline and Co., Inc., reported that producers of specialty silicas are scrambling to increase global capacity in anticipation of rising demand. Through the year 2000, the global market for specialty silicas is expected to grow at least 4% per year.[37]

The United States is the largest producer and consumer of silica sand among the market economy countries and was self-sufficient in this commodity. Most of it is produced in the eastern part of the United States, where the premier deposits and major markets are located. A significant amount of silica sand is also produced in the West and Southwest, mostly in California and Texas. Domestic production is expected to continue to meet more than 99% of demand well beyond the year 2000. Imports, mostly from Australia, Canada, and Europe are expected to remain minor.

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

Several factors could affect supply-demand relationships for silica sand. Further increases in the development of substitute materials for glass and cast metals could reduce demand for glass sand and foundry sand. These substitutes, mainly polymers and ceramics, would likely increase demand for ground silica, which is used as a filler in plastics, for glass fibers (which are used in reinforced plastics), and for silanes which may be used to manufacture ceramics. Also, increased efforts to reduce waste and increase recycling could hinder glass sand demand. However, with breakthroughs in advanced materials, silica sand may see increased consumption for fiber optics and other silicon and glass compounds. Although developments could cause demand for silica sand to decrease, the total value of production could increase because of the increased unit value of the more specialized sands.

An increase in the price of oil on the international market would stimulate domestic drilling and extraction from new and old oil deposits. This would increase demand for domestic hydraulic fracturing sand.

Concern over the use of silica as an abrasive due to health concerns and the imposition of stricter legislative and regulatory measures concerning silica exposure could decrease demands in many silica markets. Silica sand for use in the abrasive blast industry was being attacked as a health hazard as marketers of competing materials including garnet, slags, and olivine, pushed the use of their "safer" abrasive medium.

Development of more efficient mining and processing methods are expected to continue. This will enhance development of lower grade silica sand deposits closer to markets but not presently mined. Such developments are expected to increase silica sand reserves.

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TABLE 1
SALIENT U.S. INDUSTRIAL SAND AND GRAVEL STATISTICS 1/ 2/

		1991	1992	1993	1994	1995
Sold or used:						
Sand:						
Quantity	thousand metric tons	22,300	23,700	24,500	25,500	26,300
Value	thousands	$378,000	$415,000	$436,000	$466,000	$480,000
Gravel:						
Quantity	thousand metric tons	961	1,520	1,700	1,790	1,880
Value	thousands	$12,900	$19,800	$18,500	$22,400	$21,900
Total industrial:						
Quantity	thousand metric tons	23,200	25,200	26,200	27,300	28,200
Value	thousands	$390,000	$434,000	$454,000	$488,000	$502,000
Exports:						
Quantity	thousand metric tons	1,490	1,340	1,750	1,880	1,870
Value	thousands	$107,000	$90,400	$91,000	$102,000	$106,000
Imports for consumption:						
Quantity	thousand metric tons	83	164	44	24 r/	65
Value	thousands	$932	$2,450	$2,440	$1,790	$2,730

r/ Revised.
1/ Puerto Rico excluded from all industrial sand and gravel statistics.
2/ Data are rounded to three significant digits; may not add to totals shown.

TABLE 2
INDUSTRIAL SAND AND GRAVEL SOLD OR USED IN THE UNITED STATES, BY GEOGRAPHIC REGION 1/

	1994				1995			
Geographic region	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	93	(2/)	$2,370	(2/)	81	(2/)	$1,560	(2/)
Middle Atlantic	2,330	9	42,600	10	2,400	9	42,900	9
Midwest:								
East North Central	10,300	38	158,000 r/	32	10,400	37	161,000	32
West North Central	1,910	7	39,900	8	1,900	7	41,000	8
South:								
South Atlantic	4,000 r/	15	77,400	16	4,070	14	76,300	15
East South Central	1,350	5	20,400	4	1,470	5	22,300	4
West South Central	3,940	14	79,500	16	4,110	15	84,600	17
West:								
Mountain	1,440	5	23,100	5	1,790	6	28,400	6
Pacific	1,970	7	44,500	9	1,960	7	44,000	9
Total	27,300	100	488,000	100	28,200	100	502,000	100

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Less than 1/2 unit.

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

(Thousand metric tons and thousand dollars)

State	1994		1995	
	Quantity	Value	Quantity	Value
Alabama	610	7,160	479	5,940
Arizona	W	W	334	2,910
Arkansas	W	W	W	W
California	1,740	39,400	1,710	38,300
Colorado	W	W	W	W
Connecticut	W	W	--	--
Florida	540	6,120	547	6,340
Georgia	440	7,040	574	7,060
Idaho	481	7,410	501	8,720
Illinois	4,420	65,700	4,410	67,500
Indiana	120	1,010	W	W
Iowa	W	W	W	W
Kansas	W	W	W	W
Louisiana	454	9,320	572	10,500
Maryland	W	W	W	W
Massachusetts	W	W	--	--
Michigan	2,870	31,300	2,940	30,600
Minnesota	W	W	W	W
Mississippi	W	W	W	W
Missouri	559	9,970	W	W
Montana	W	W	W	W
Nebraska	W	W	W	W
Nevada	572	W	W	W
New Jersey	1,690	30,600	1,760	31,000
New York	W	W	W	W
North Carolina	1,460	24,200	1,330	21,900
North Dakota	W	W	W	W
Ohio	1,260	27,700	1,270	28,800
Oklahoma	1,230	24,000	1,250	25,400
Pennsylvania	W	W	W	W
Rhode Island	W	W	W	W
South Carolina	699	18,100	839	20,500
Tennessee	659	11,600	918	14,700
Texas	1,570	37,900	1,600	40,300
Virginia	W	W	W	W
Washington	W	W	W	W
West Virginia	W	W	W	W
Wisconsin	1,630	32,400	1,670	33,300
Other	4,320	96,500	5,500	109,000
Total	27,300	488,000	28,200	502,000

W Withheld to avoid disclosing company proprietary data; included with "Other."
1/ Data are rounded to three significant digits; may not add to totals shown.

TABLE 4
INDUSTRIAL SAND AND GRAVEL PRODUCTION IN THE UNITED STATES IN 1995, BY SIZE OF OPERATION 1/

Size range	Number of operations	Percent of total	Quantity (thousand metric tons)	Percent of total
Less than 25,000	21	15	228	1
25,000 to 49,999	16	11	582	2
50,000 to 99,999	29	20	1,980	7
100,000 to 199,999	27	19	3,540	13
200,000 to 299,999	13	9	3,000	11
300,000 to 399,999	13	9	4,160	15
400,000 to 499,999	7	5	2,850	10
500,000 to 599,999	4	3	2,040	7
600,000 to 699,999	7	5	4,090	15
700,000 and over	7	5	5,730	20
Total	144	100	28,200	100

1/ Data are rounded to three significant digits; may not add to totals shown.

TABLE 5
NUMBER OF INDUSTRIAL SAND AND GRAVEL OPERATIONS AND PROCESSING PLANTS IN THE UNITED STATES IN 1995, BY GEOGRAPHIC REGION

	Mining operations on land					
Geographic region	Stationary	Portable	Stationary and portable	No plants or unspecified	Dredging operations	Total active
Northeast:						
New England	1	--	--	--	--	1
Middle Atlantic	9	--	2	1	4	16
Midwest:						
East North Central	37	1	--	--	1	39
West North Central	5	--	--	--	6	11
South:						
South Atlantic	16	--	1	3	5	25
East South Central	8	--	1	--	2	11
West South Central	7	--	--	1	12	20
West:						
Mountain	8	2	1	--	--	11
Pacific	8	--	--	1	1	10
Total	99	3	5	6	31	144

TABLE 6
INDUSTRIAL SAND AND GRAVEL SOLD OR USED BY U.S. PRODUCERS IN 1995, BY MAJOR END USE 1/

(Thousand metric tons and thousand dollars)

Major use	Northeast			Midwest			South			West			U.S. total		
	Quantity	Value	Value per ton 2/	Quantity	Value	Value per ton 2/	Quantity	Value	Value per ton 2/	Quantity	Value	Value per ton 2/	Quantity	Value	Value per ton 2/
Sand:															
Glassmaking:															
Containers	950	15,900	$16.74	1,770	18,900	$10.67	1,800	27,000	$15.02	1,160	24,700	$21.37	5,680	86,600	$15.24
Flat (plate and window)	W	W	15.65	812	8,910	10.98	1,450	22,400	15.40	W	W	16.69	2,840	40,700	14.35
Specialty	W	W	20.70	382	6,790	17.77	398	6,890	17.31	W	W	29.88	1,030	19,100	18.51
Fiberglass (unground)	W	W	5.94	333	4,960	14.91	467	14,000	29.90	W	W	21.00	973	21,200	21.81
Fiberglass (ground)	--	--	--	W	W	41.42	W	W	39.04	--	--	--	167	6,600	39.51
Foundry:															
Molding and core	W	W	18.60	5,310	66,600	12.55	1,050	13,000	12.45	W	W	22.40	6,760	87,500	12.94
Molding and core facing (ground)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Refractory	W	W	15.00	63	1,290	20.43	W	W	48.38	(3/)	6	20.65	80	1,820	22.69
Metallurgical:															
Silicon carbide	--	--	--	W	W	16.74	--	--	--	--	--	--	W	W	16.74
Flux for metal smelting	--	--	--	W	W	10.00	W	W	4.82	W	W	5.93	264	1,630	6.16
Abrasives:															
Blasting	133	3,520	26.49	261	7,270	27.84	1,240	22,600	18.19	135	4,360	32.31	1,770	37,700	21.31
Scouring cleansers (ground)	--	--	--	W	W	55.33	W	W	38.00	--	--	--	W	W	68.00
Sawing and sanding	W	W	19.00	--	--	--	W	W	15.91	--	--	--	W	W	20.00
Chemicals (ground and unground)	W	W	18.60	W	W	12.93	228	5,770	25.29	60	1,190	19.77	641	12,100	18.82
Fillers (ground):															
Rubber, paints, putty, etc.	W	W	283.00	84	6,280	74.76	88	15,700	178.73	W	W	22.00	178	22,400	125.85
Whole grain fillers/building products	96	1,770	18.41	529	12,500	23.54	467	10,700	22.84	274	6,920	25.27	1,370	31,800	23.29
Ceramic (ground):															
Pottery, brick, tile, etc.	W	W	31.75	131	6,650	50.76	109	4,090	37.55	W	W	33.00	253	11,200	44.10
Filtration:															
Water (municipal, county, local, etc.)	62	1,710	27.60	71	2,070	29.18	127	1,450	11.39	71	2,630	37.07	331	7,860	23.75
Swimming pool, other	W	W	45.20	W	W	33.00	35	1,390	39.63	--	--	--	69	2,630	38.13
Petroleum industry:															
Hydraulic fracturing	--	--	--	1,170	40,300	34.60	W	W	30.84	W	W	34.52	1,580	53,000	33.67
Well packing and cementing	--	--	--	13	1,730	133.38	16	274	17.13	--	--	--	29	2,010	69.24
Recreational:															
Golf course (greens and traps)	102	1,530	14.99	173	2,570	14.88	237	2,180	9.19	168	3,180	18.95	680	9,460	13.92
Baseball, volleyball, play sand, beaches	92	977	10.62	8	114	14.25	99	876	8.85	34	628	18.47	234	2,600	11.09
Traction (engine)	38	555	14.61	143	1,360	9.53	121	1,620	13.40	34	685	20.15	336	4,220	12.57
Roofing granules and fillers	31	660	21.29	W	W	3.30	149	1,760	11.80	W	W	12.78	248	2,810	11.35
Other (ground silica)	13	664	51.08	W	W	23.57	W	W	31.75	W	W	21.62	XX	XX	XX
Other (whole grain)	556	9,910	20.68	483	7,580	32.73	749	16,900	13.05	613	9,880	22.27	XX	XX	XX
Total or average	2,410	43,400	18.03	11,800	199,000	16.82	8,970	174,000	19.39	3,130	64,400	20.57	26,300	480,000	18.25
Gravel:															
Silicon, ferrosilicon	--	--	--	W	W	16.67	W	W	13.09	--	--	--	532	7,160	13.45
Filtration	W	W	35.65	W	W	11.59	W	W	16.70	--	--	--	150	2,400	16.01
Nonmetallurgical flux	--	--	--	--	--	--	W	W	18.77	W	W	13.65	590	8,450	14.31
Other uses, specified	W	W	8.05	362	1,610	4.45	76	787	10.36	W	W	9.46	607	3,910	6.44
Total or average	75	1,070	14.32	504	3,540	7.01	676	9,260	13.70	624	8,050	12.90	1,880	21,900	11.66
Grand total or average	2,480	44,500	17.91	12,300	202,000	16.42	9,650	183,000	18.99	3,760	72,500	19.29	28,200	502,000	17.81

W Withheld to avoid disclosing company proprietary data; included in "U.S. Total" and/or "Total or average." XX Not applicable.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Calculated using unrounded data.

3/ Less than 1/2 unit.

TABLE 7
U.S. EXPORTS OF INDUSTRIAL SAND AND GRAVEL, BY COUNTRY 1/

(Thousand metric tons and thousand dollars)

Country	1994		1995	
	Quantity	F.a.s. value 2/	Quantity	F.a.s. value 2/
North America:				
Bermuda	10	62	(3/)	5
Canada	1,480	20,100	1,430	20,200
Mexico	159	2,900	129	5,270
Panama	11	166	12	172
Other	11	523	9	616
Total	1,670	23,800	1,580	26,200
South America:				
Argentina	29	1,280	9	1,210
Brazil	12	900	2	948
Peru	3	290	2	224
Venezuela	4	649	5	857
Other	(3/)	589	3	432
Total	48	3,710	21	3,670
Europe:				
Germany	22	12,600	41	13,700
Italy	4	1,020	4	2,350
Netherlands	6	3,840	49	9,630
United Kingdom	24	2,270	6	1,960
Other	15	4,630	22	5,050
Total	71	24,300	122	32,700
Asia:				
Hong Kong	11	7,050	9	2,030
Japan	43	29,700	52	24,400
Korea, Republic of	7	2,980	12	3,800
Singapore	5	2,400	8	4,400
Taiwan	19	4,780	53	5,740
Other	4	1,960	8	1,880
Total	88	48,900	142	42,200
Middle East and Africa:	5	628	3	824
Oceania:				
Australia	2	547	1	644
Other	(3/)	115	(3/)	28
Total	2	662	1	672
Grand total	1,880	102,000	1,870	106,000

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Value of material at U.S. port of export; based on transaction price, including all charges incurred in placing material alongside ship.
3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF INDUSTRIAL SAND, BY COUNTRY 1/

(Thousand metric tons and thousand dollars)

Country	1994		1995	
	Quantity	C.i.f. value 2/	Quantity	C.i.f. value 2/
Australia	12 r/	644	62	1,580
Belgium	--	--	(3/)	36
Canada	1	103	1	146
Germany	(3/)	145	1	301
Guyana	9 r/	150	(3/)	12
Italy	(3/)	36	--	--
Japan	(3/)	234	(3/)	218
Mexico	(3/)	2	--	--
Russia	--	--	(3/)	6
Sweden	2	415	1	403
United Kingdom	(3/)	7	(3/)	17
Venezuela	(3/)	57	(3/)	11
Total	24 r/	1,790	65	2,730

r/ Revised.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Value of material at U.S. port of entry; based on purchase price and includes all charges (except U.S. import duties) in bringing material from foreign country to alongside carrier.

3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 9
INDUSTRIAL (SILICA) SAND AND GRAVEL: WORLD PRODUCTION BY COUNTRY 1/ 2/

(Thousand metric tons)

Country 3/	1991	1992	1993	1994	1995 e/
Argentina	374	340	396	380 e/	390
Australia e/	2,000	2,000	2,000	2,500	2,500
Austria	2,090	5,884	4,302	6,457	7,503 4/
Belgium e/	2,554 4/	2,480	2,480	2,480	2,500
Bosnia and Herzegovina	XX	50	50	50	50
Brazil e/	2,700	2,700	2,700	2,700	2,700
Canada	1,495	1,754	1,600 e/	1,600 e/	1,650
Chile e/	300	300	300	300	300
Croatia e/	XX	40 r/	23 r/	25 r/	15
Cuba e/	500	450	400	300 r/	300
Czech Republic	XX	XX	1,758	1,957	1,993
Czechoslovakia 5/	1,902	2,010	XX	XX	XX
Denmark (sales) e/	325	315	315	315	300
Ecuador	330 r/	363 r/	164 r/	170 r/ e/	170
Egypt e/ 6/	500	500	500	500	500
Estonia e/ 7/	XX	30	25	25	25
Finland	201	169	167	72 r/	75
France e/	3,500	6,300	5,400	7,280 r/	7,000
Germany	11,000 e/	10,706	9,768	10,840 r/	10,000
Guatemala	17	34	27 e/	27 r/ e/	29
Hungary 8/	1,250 r/	1,350 r/	440 r/	512 r/	504
Iceland e/	5	5	5	5	5
India	1,924	1,316	1,148 r/	1,246 r/	1,300
Indonesia	429	400 e/	240	240 e/	250
Iran 9/	832	756	932	950 e/	1,000
Ireland e/	7	7	7	8	7
Israel e/	60	60	60	60	60
Italy e/	4,200	4,000	4,000	4,000	4,000
Jamaica	16	20 r/	21	18	20
Japan	4,343	3,843	3,883	3,942	3,737 4/
Kenya e/	12	12	12	12	12
Korea, Republic of e/	1	2	2	2	2
Latvia e/ 7/	XX	110	90	76 r/ 4/	91 4/

See footnotes at end of table.

TABLE 9--Continued
INDUSTRIAL (SILICA) SAND AND GRAVEL: WORLD PRODUCTION BY COUNTRY 1/ 2/

(Thousand metric tons)

Country 3/	1991	1992	1993	1994	1995 e/
Lithuania e/ 7/	XX	80	60	60	40
Malaysia	668	579	355	231	288 4/
Mexico	1,198	1,129	1,310	1,360	1,293 4/
Netherlands e/	25,000	20,000	20,000	25,000	23,000
New Caledonia e/	31	31	31	39	40
New Zealand	594	500	720	750 e/	750
Norway e/	800	900	900	900	900
Pakistan	151	135	168	170 e/	170
Panama	18	23	23 e/	23 e/	23
Paraguay e/	1,500 r/	1,000 r/	1,000 r/	1,500 r/	1,500
Peru	150	152	115 r/	100 r/	100
Philippines	532	744 r/	828	800 e/	800
Poland	1,089	931	1,020	911	952
Portugal e/	5	5	5	5	5
Serbia and Montenegro	XX	922 r/	270 r/	403 r/	400
Slovenia	XX	310 r/	210 r/	210 r/	210
South Africa	2,068	1,750	1,738	1,920	2,180 4/
Spain e/	2,200	2,178 4/	2,200	2,000	2,000
Sweden	1,474	1,433	1,500 e/	1,500 e/	1,500
Tanzania	4	4	4 e/	4 e/	--
Thailand	657	594	459	471	470
Turkey e/ 10/	592 r/ 4/	510	350 r/	415 r/	700
United Kingdom e/	3,900	3,615 4/	4,000	3,600	3,600
United States (sold or used by producers)	23,200	25,200	26,200	27,300 r/	28,200 4/
Venezuela	343	703	753	141 r/	598 4/
Yugoslavia 11/	2,100	XX	XX	XX	XX
Zimbabwe 12/	70	77	80	130 e/	130
Total	111,000 r/	112,000 r/	108,000 r/	119,000 r/	119,000

e/ Estimated. /r Revised. XX Not applicable.

1/ Table includes data available through July 19, 1996.

2/ World totals, U.S. data, and estimated data are rounded to three significant digits; may not add to totals shown.

3/ In addition to the countries listed, Angola, Antigua and Barbuda, The Bahamas and China, among others, produce industrial sand, but current available information is not adequate to formulate estimates of production levels.

4/ Reported figure.

5/ Dissolved Dec. 31, 1992. All production for 1991-92 came from Czech Republic.

6/ Fiscal years beginning July 1 of that stated.

7/ Formerly part of the U.S.S.R., which was dissolved in Dec. 1991. Information was inadequate to formulate reliable estimates of production prior to 1992.

8/ For the reported volumetric quantity, see the U.S.G.S. Minerals Yearbook 1995, v. III.

9/ Fiscal years beginning Mar. 21 of that stated.

10/ Washed product.

11/ Dissolved in Apr. 1992.

12/ Includes rough and ground quartz as well as silica sand.