Silica/Quartz

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Quartz (i.e., SiO_2, also referred to as silicon dioxide or silica) is one of the most common minerals on the face of the earth with numerous uses. It is produced and consumed in most countries. Annual world production of silica is estimated at 120-150 Mt.

Quartz is not the only mineral composed of SiO_2. There are eight other known structures composed of SiO_2. They are polymorphs of silicon dioxide and belong to an informal group called the Quartz Group or Silica Group.

SUMMARY

In Canada, silica is recovered in: a) lump form for use as metallurgical flux and in the manufacture of silicon and ferrosilicon alloys; b) as sand for glass and glass fibre manufacture, foundry moulding, silicate chemicals, silicon chips and optical fibres; and c) as finely ground silica flour for ceramics, asbestos cement and concrete products (Table 4).

Although Canada is self-sufficient for most of its silica requirements, significant tonnages of high-quality sand for glass and foundry applications are imported, mainly by Ontario from the United States. As a result of widespread availability and low prices, trade is restricted to convenient cross-border shipments. However, silica with the desired specifications for specific applications may be shipped to large, distant markets.

Preliminary data reported by users (Table 3) in Canada show that silica use was almost 2.5 Mt in 2003, a decrease of 104 657 t from the previous year. Preliminary data (Table 1) reported by Canadian producers for 2004 indicate production was valued at $46.6 million, a $4.8 million increase from 2003, reflecting the increase in shipments to 1.69 Mt from 1.58 Mt in 2003. Preliminary imports were valued at $108.0 million for 2004, almost a $0.8 million increase from 2003, with the tonnage quantity for imports increasing to almost 1.4 Mt from 872 397 t in 2003. Preliminary exports for 2004 represented close to $16.0 million, an increase of almost $4.0 million compared to exports in 2003, a reflection of the quantity increase to 683 914 t from 354 685 t in 2003.

Preliminary data for 2003 (Table 3)[1] show that the nonferrous smelting and refining industry represents 29.5% of the total use of silica in Canada and sustained a decrease of 22.8% from 2002. The primary glass and glass containers, and glass fibre wool sectors represented 19.9% of total use and also sustained a decrease of only 3.9% from 2002. Foundries, which represented 9.8% of the total use of silica in Canada, observed a decrease of 5.3% compared to 2002. As for silica use by the chemicals industry and the "other products" category sector, they respectively represent 3.4% and 37.4% of total use, and both observed an increase of 4.2% and 18.1% compared to 2002 usage.

With respect to the reported quantity of silica used by category (Table 4), sand represents 66.5% (almost 1.7 Mt) of the total. For lump silica, which represents 30.7% (767 821 t) of the total, a slight decrease of 68 769 t from 2002 is observed. Preliminary data for flour, which represents 2.8% (69 967 t) of the total, indicate an increase of 15 536 t from 2002. The flour usage decrease in 2002 from 2001 data (111 108 t) was attributable to one company's decision to replace its consumption of silica flour with silica sand.

OCCURRENCE

Silica occurs mainly as the mineral quartz. Quartz occurs in many forms, the common being vein and massive intrusive bodies, silica sand, sandstone and quartzite. Quartz also occurs as crystals and as masses or aggregates in

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[1] Reported use of silica by Canadian manufacturing companies is done by surveys on a voluntary basis and might not reflect 100% consumption coverage. In addition, data may not include silica purchased for exports resale.

igneous rocks such as granites or pegmatites. Amorphous, non-crystalline varieties of quartz are less common and include opal, flint, chalcedony, tripoli, and diatomaceous earth.

Although all occurrences of silica are of interest from a geological point of view, commercial interest and development are usually restricted to vein or intrusive deposits and to silica sand, sandstone and quartzite deposits. Vein and intrusive deposits are igneous in origin and vary widely in shape and size. Such deposits are widespread throughout Canada. The quartz usually varies from white to grey and is relatively free of impurities.

Silica sand has a high silica content (95% SiO_2 or more). The silica or quartz particles, derived from the mechanical disintegration and chemical decomposition of siliceous rocks, have been selectively sorted and concentrated by the action of wind or water during transport to new locations where they accumulated to form high-grade deposits.

Sandstone is a sedimentary rock composed of quartz grains cemented by a bonding mineral. Sandstones, in which the bonding material is clay, calcite or iron oxide, are usually quite friable and easily reduced to grain size. Others may be more firmly cemented by a siliceous cement and thus are more difficult to reduce to grain size. Most sandstones are white, grey or brown and usually contain varying amounts of mineral impurities, e.g., feldspar, hornblende, magnetite, pyrite, iron oxide stain and mica.

Quartzite is a hard, compact, metamorphosed sandstone composed of grains of quartz firmly bonded with a siliceous cement. The original quartz grains, having coalesced with the siliceous cement to form a continuous homogeneous mass, are not apparent to the naked eye.

TRADE

Imports for 2004 (Table 1) from the United States accounted for 93.9% of all imports (over 1.3 Mt) from all countries. Imports of silica sands and quartz sands from the United States have increased 51.4% (421 618 t) from 2003. Imports from the United States come from loosely consolidated and easily processed sandstone or lake sand deposits located near the Great Lakes. Major U.S. operations are located in the states of Illinois, Wisconsin, Michigan and Indiana.

Combined 2004 imports from the foundry and glass industry totaled 619 824 t. The tonnage of imports by the foundry industry decreased by 20% from 2003 to 2004. Demand for foundry sand is dependent mainly on automobile and light truck production.

Preliminary data for 2004 indicate that Canada's exports (Table 1) of silica totaled 683 914 t, an increase of 93% from 2003. The value of these exports totaled almost $16 million, an increase of 33% over the 2003 value of almost $12 million. The major increase in the quantity exported is principally due to the quartz, silica sands, and quartz sands categories. Of all the exports from Canada to various countries, 649 636 t (95%) were to the United States.

PRODUCTION AND MARKET CONSIDERATIONS

The economics of the production and sale of the many types of silica are governed by many factors, but world demand for silica is controlled mostly by the fortunes of the glass and foundry industries. Throughout North America, the silica sand industry is highly competitive and the industry is dominated by a few large producers. A silica sand source location close to its users is important due to transportation cost considerations and thus silica is shipped only to local or regional markets. Beneficiation is the key to producing high-quality glass or foundry sand from most deposits.

The diverse uses of silica and quartz complicate its market demand analysis. In the glass sector, construction and automobile markets drive flat glass sales, new construction being the basis for fibreglass sales. These markets are driven by the Gross Domestic Product. Silica sand demand in container glass is influenced by reductions in the number of consumption points through industry rationalization; decreased production as a result of strong competition from PET bottles (i.e., made of virgin resin of polyethylene terephthalete), aluminum, and paper containers; and increasing and mandated recycling rates in the glass container industry. Use in foundry applications depends on metal production (depending upon automobile sales, etc.) combined with recycling efficiencies and competitive sands. Overall, demand for foundry sand has been reduced by the advent of continuous casting in the steel industry. Hydraulic fracturing sand demand is influenced by the price of oil, regional oil production factors such as flow rate and pressure, and changes in drilling technologies.

SUPPLY

Silica deposits of commercial interest occur in all 10 provinces. The important Canadian production sites are discussed below. The provinces of Quebec, Ontario and Alberta are the main producers of silica, followed by Saskatchewan, British Columbia and Nova Scotia. Generally, silica mining uses open-pit or dredging mining methods.

Newfoundland and Labrador

Shabogamo Mining and Exploration Co. Ltd. began mining its Roy's Knob quartzite deposit near Labrador City in October 1999. The company's washing and screening plant is located in Wabush, Labrador. The quartzite product is sent by rail to Sept-Îles, Quebec. Shabogamo supplies quartzite to Silicium de Bécancour Inc. of Quebec, which uses the material to manufacture silicon metal.

Prince Edward Island

There are no silica quarries currently in operation.

Nova Scotia

Shaw Resources Ltd., a member of The Shaw Group Limited, produces a high-purity (98.5-99.5%) silica from sand deposits located at Nine Mile River, Hants County, near Shubenacadie. In addition, fine sand from its silica operation is beneficiated to flint glass-grade material. Fine sand products are sold in the Maritimes, Quebec and northeastern United States for use in sandblasting, filter sand, traction sand, cement and concrete manufacturing, refractory and decorative sand, and as a flux for base-metal smelters.

British Columbia's Black Bull Resources Inc. commenced mining at its White Rock quartz project in Yarmouth County. The site is located 42 km northwest of the deep port of Shelburne. Reserves of 16.3 Mt of high-quality quartz have been estimated.

New Brunswick

Shaw Resources' Chaleur Silica Ltd. – a division of The Shaw Group Limited currently operates the Bass River silica quarry providing silica as flux material to the nearby Belledune lead smelter and silica for use in cement manufacture. It also manufactures abrasive products using raw material from Nova Scotia, Ontario and the United States.

Since 1986, Atlantic Silica Inc. mines and processes a high-grade (+98%) silica deposit 22 km southwest of Sussex near Cassidy Lake. The quartz pebbles have been used to produce silicon metal and decorative stone. The quartz sand has been marketed for use in sandblasting, silicon carbide, nursery grit, cement powder, glass, golf course sand, smelter flux sand and filtration sand. Most of it is used in eastern Canada, although some is shipped to the United States.

Quebec

Unimin Canada Ltd., a subsidiary of Unimin Corp. of the United States, is the largest producer of silica in the province. Silica is mined from a quartzite deposit at Saint-Donat-de-Montcalm and from a sandstone deposit at Saint-Canut. Silica from Saint-Donat is shipped and refined at the Saint-Canut plant near Montréal. The majority of the silica produced by Unimin originates from Saint-Canut where the ore is ground, screened and beneficiated by magnetic separation. Most of Unimin's output is used in the production of glass containers, flat glass and fibreglass, and also in the silicon carbide industries.

Silicium Bécancour Inc. operates the silica plant in Bécancour. It also owns the quartzite deposit north of La Malbaie that is being developed by Sitec Inc. Sitec Inc. is a joint venture between Baskatong Quartz Inc. and SOQUEM INC. Sitec mines and processes high-purity quartz in Malbaie, Quebec, for a range of end uses, including silicon metal and silicon carbide. The company also operates a custom crushing, drying, and screening plant in Shawinigan, Quebec.

La Compagnie Bon Sable Ltée mines silica sand at Saint-Joseph-du-Lac and Ormstown. The material is used mainly for sandblasting and as a concrete sand; it is also suitable for the production of fibreglass.

Silco Sands Inc. mines and grinds its silica at its plant in Sainte-Clotide-de-Châteauguay. The products are sold to a chemical company, a cement plant and a ferromanganese plant.

Temisca Inc., a division of Opta Minerals Inc., mines and processes silica near Saint-Bruno-de-Guigues for the golf course, filtration sand, frac, abrasives and construction markets. The processing facility includes a 200 000-t/y hydrosizer as well as screening, drying and packaging equipment.

Béton provincial ltée operates a silica sandstone quarry in Gaspé's La Rivière County and Société Minière Gerdin Inc. operates a silica sand quarry on a seasonal basis in Saint-Rémi-d'Amherst.

Exploration Québec/Labrador (EQL) Inc. mines its quartz deposit from Lac Daviault, near Fermont. Production is crushed on site, but is processed at the Granirex plant (division of DuPont Canada of Ontario) in Thedford Mines, Quebec, for the manufacturing of decorative and durable engineered stone products used in decorative surface applications. EQL is planning to explore other markets for the quartz, including silicon metal.

Ontario

Unimin Canada Ltd. is also the largest producer of silica in Ontario with a capacity of about 500 000 t/y. Lump quartzite from Badgeley Island (150 000-t/y capacity) in northern Georgian Bay is shipped by boat to Canadian destinations for the manufacture of ferrosilicon. The finer material, produced by grinding, is shipped to Unimin's plant at Midland (400 000-t/y capacity), south of Georgian

Bay, where it is further processed to a glass-grade silica sand and silica flour for ceramic and other uses.

Crystal Quartz Canada, located near Dryden in western Ontario, is the only lascas-grade silica producer in North America. It supplies lascas quartz to North American cultured quartz producers.

Significant amounts of silica are extracted by others across Ontario for use as flux for base-metal ores smelting operations in Timmins and Sudbury, for silicon metal production, for specialty brick production, and for decorative uses. Other Ontario producers are: Arriscraft International Inc. with its Elgin Quarry in Bastard Township; Rapier Resources Inc. with its Deagle Township Quarry, west of Sudbury; Great White Minerals Ltd. with its Fripp Quarry, near Timmins; Northern Mining and Exploration Inc. with its Shaw Township Quarry, in Timmins; and Roseval Silica with its Penhorwood Township Quarry, also near Timmins.

Manitoba

There are no known silica quarries currently in operation.

Saskatchewan

Hudbay Minerals Inc. (formerly Hudson Bay Mining and Smelting Co., Limited) produces silica in the Amisk Lake area of northern Saskatchewan and is the largest user of the province's silica sand at its Flin Flon, Manitoba, smelter. Hudbay uses sand as a fluxing agent that, in the molten state, reacts with various impurities in the copper concentrate to produce a slag. The slag produced with the impurities drawn off leaves a refined metal.

Red Deer Silica Inc. produces a small amount of silica, northeast of the village of Hudson Bay, for use in golf course bunkers, stucco sand and sandblasting sand.

In mid-2002, the mineral deposit of the Hanson Lake silica sand project was appropriated by Trican Well Services and Saskatchewan Opportunities Corporation (SOCO). The mineral dispositions have been optioned to Winn Bay Sand Ltd., a company affiliated with the Ochapwace First Nation. Lonesome Prairie Sand and Gravel Ltd. is the contractor carrying out all quarrying operations. All processing takes place on site. The silica sand is used as frac sand, predominantly in the gas fields in Saskatchewan. The silica sand is transported to Burstall, Saskatchewan, just west of the Great Sand Hills, where it is offloaded. Customers pick up their orders from this site.

Alberta

Sil Industrial Minerals Inc. of Edmonton produces silica sand from local sand dunes in the Bruderheim area. It also operates a silica processing facility near Edmonton. The silica is sold mainly for the manufacture of fibreglass and as sandblasting material. Other uses are in foundry, filtration, fracturing and railway traction applications. The company also produces silica flour by processing the silica sand through a ball mill. The flour is used in thermal insulating cement in the oil and gas industries.

Cementec Industries Inc. of Calgary produces, among other unique and proprietary products, silica flour, silica fume and sandblasting sand for use in the oil and gas and construction industries.

British Columbia

Dynatec Corp. of Calgary, Alberta, mines a high-purity (99.5%) silica sand for diverse industrial applications (e.g., glass grade) at the Moberly mine in the Golden area. The friable sandstone is ground, screened, washed, dried and separated into several sizes at a plant near Golden. These different sizes are sold mainly as glass sand, but also as sandblasting sand, foundry sand, filter media sand and golf course sand.

Lafarge Canada Inc. mines silica-alumina material from the Buse Lake deposit as feedstock for its Kamloops cement plant.

PRICES

Prices for actual transactions vary according to geographic region and will take into account the quantity purchased, application, quality assurance, exact grade purchased, credit terms, and other parameters. Due to the unavailability of Canadian prices, the following price examples from other sources are provided to facilitate an understanding. The May 2004 edition of *Industrial Minerals* magazine reported that silica sand prices (ex-works, U.K. foundry sand, dry, bulk) were in the range of £15.50-£16.50/t (C$38.54-$41.02/t). The price range for the other categories (glass sand, flint, container, ex-works) was £15-£17/t (or C$37.29-$42.26/t). Ex-works USA (foundry sand, dry, bulk) prices were in the range of US$14.00-$25.00/t (or C$19.22-$34.31).

U.S. prices (source: U.S. Geological Survey[2] [USGS] *2003 Review*), as an example, for the North American market, when compared with the average value of 2002 (i.e., the average value, free on board [f.o.b.] plant) for U.S. industrial sand and industrial gravel, increased by about 6% to US$22.17/t in 2003. The average unit values for industrial sand and industrial gravel were US$22.54/t

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[2] Different countries have different terminology and specifications for silica. In the United States, industrial sand and gravel is often called "silica," "silica sand" and "quartz sand," which include sand and gravel with high silicon dioxide content.

and US$13.47/t, respectively. The average price for sand ranged from US$7.00/t for metallurgical flux to US$85.29/t for ground foundry sand. For gravel, prices ranged from US$9.07/t for other uses to US$40.08/t for filtration. U.S. producer prices reported to the USGS for silica commonly ranged from several dollars per tonne to hundreds of dollars per tonne, and occasionally exceeded the US$1000/t level. In the United States, ground sand for foundry molding and core, at US$85.29, had the highest value per tonne, followed by silica for swimming pool filters, US$73.76; ground sand used as fillers for paint, putty and rubber, US$73.50; ground sand for scouring cleansers, US$54.26; ground sand for ceramics, US$51.90; silica for municipal water filtration, US$49.75; ground sand for well packing and cementing, US$42.04; and sand for hydraulic fracturing, US$40.72.

MAJOR USES AND SPECIFICATIONS

Silica in the form of quartz, sand, sandstone and quartzite is used in many applications. Uses may be subdivided on the basis of particle size requirements, e.g., lump silica, 2 or 3 mm to 15 cm or more in size; silica sand, 2 or 3 mm in size down to 75 μm; and silica flour, which is essentially minus 75 μm in size. Applications for the silica with general specifications are discussed under the three general size categories stated (CANMET, *Summary Report No. 4: Silica*).

Lump Silica[3]

Flux: Quartz, quartzite and occasionally sandstone and sand are used as fluxes in smelting base-metal ores with low silica contents. The silica content of the flux should be as high as possible, but a small percentage of impurities such as iron oxide and alumina can be tolerated. Size is generally minus 2.5 to 0.5 cm.

Silicon Alloys: Quartz, quartzite and well-cemented sandstone are used in the manufacture of silicon, ferrosilicon and other alloys of silicon. The silica content of ferrosilicon should be 98% and the total iron oxide and alumina less than 1.5%. Lime and magnesia should not exceed 0.20% each; phosphorous and arsenic should also be very low. Silicon metal manufacture requires a high-purity quartz grading 99.5% SiO_2 or better with less than 0.04% iron oxide and alumina. Size specifications vary between 5 and 10 cm.

Silica Brick: Quartz and quartzite crushed to 2.5 mm are used in the manufacture of silica brick for high-temperature refractory furnace linings. The silica content should be a minimum of 95%, and iron oxide and alumina should each be less than 0.1%. Other impurities such as lime and magnesia should be low.

Other Uses: Lump quartz and quartzite are used as linings in ball and tube mills, and as lining and packing for acid towers. Naturally occurring flint pebbles may be used as a grinding medium for nonmetallic ores.

Silica Sand[3]

Glass and Glass Fibre: Naturally occurring quartz sands and sands produced by crushing quartz, quartzite or sandstone are used in the manufacture of glass, glass fibre and fused silica ware. The silica content should be greater than 99% and the iron oxide content should be uniform and less than 0.025%.

Other impurities such as alumina, lime and magnesia should be less than 0.15% each. Chromium, cobalt and titanium are undesirable and should be less than 2 or 3 ppm. Uniformity of grain size is important and sand generally should be between 600 and 100 μm in size with a minimum of coarse and fine material.

Silicon Carbide: Sand for silicon carbide manufacture should have a silica content of 99% and iron oxide and alumina should each be less than 0.1%; lime, magnesia and phosphorous are particularly objectionable. Although coarse-grained sand is preferred, finer sands are used where coarser grades are not available. All sand should be plus 150 μm, with the bulk of the sand being minus 2.0 to plus 0.5 mm in size.

Hydraulic Fracturing: Silica sand is used as a "propping agent" in the hydraulic fracturing of oil-bearing formations to improve the recovery of oil. The sand should be clean, dry and have a high compressive strength. The silica content should be high and carbonates and other acid-consuming minerals should be low. The sand grains should be between 850 and 500 μm in size and be well rounded to facilitate placement and provide maximum permeability.

Foundry Moulding: Naturally occurring sand and sand produced by the reduction of sandstone to grain size are used extensively in the foundry industry for moulding purposes. The purity and size of sand used depend on the type of casting and on the particular foundry practice. Iron and steel foundry sands vary in grain size between 850 and 75 μm in closely sized fractions. American Foundryman's Society (AFS) numbers vary between 55 and 65μm, with the bulk of the sand being preferably on three adjacent sieves; a rounded grain shape is preferred. The silica content should be high, 99% SiO_2,with low aluminum, iron, sodium and potassium oxides.

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[3] High-purity quartz, quartz crystal and silica sand are used as starting materials in the production of artificial quartz crystal, fused quartz and optical fibres. The silica content should be as high as possible and the metallic elements should be as low as possible, usually in the ppm range.

Silicate Chemicals: Sand for the manufacture of sodium silicate and other chemicals should be of high purity. Sodium silicate requires a silica content of 99%, the alumina less than 1%, the combined lime and magnesia less than 0.5%, and iron oxide less than 0.1%. All sand should be between 840 and 150 μm in size.

Other Uses: Coarsely ground, closely sized quartz, quartzite, sandstone and sand are used as abrasive grit for sandblasting purposes and for the manufacture of abrasives papers. Various grades of closely sized, round-grained sand are used in water filtration plants as a filtering medium. Silica sand is used as an additive in portland cement manufacture when the source cement is low in silica.

Silica Flour

Silica flour, formed by grinding quartz, quartzite, sandstone and sand to 75 μm and finer, is used in the ceramic industry for enamel frits and pottery flint. It is also used in the manufacture of asbestos cement and autoclave-cured concrete products, as an inert filler/extender mineral in rubber and paints, and as an abrasive ingredient in soaps and scouring powders.

MINING, PROCESSING AND BENEFICIATION

Mining

Commercial silica is obtained from vein quartz, sand, sandstone and quartzite deposits. Mining is usually by an open-pit benching using standard quarrying methods. Following primary breakage, the rock is trucked to the mill site for further size reduction, processing and beneficiation.

Processing

Silica may be used in the lump form, as sand, as a finely ground powder, and as silica flour. Primary crushing of lump silica is readily accomplished by jaw and cone crushers, and secondary crushing is done by hammer or impact-type mills. Further reduction to sand size may be accomplished by roll crusher or rod mill, and to flour size or finer by ball, vibratory or jet-milling, or by attrition grinding in a “stirred” ball mill using small ceramic pebbles as grinding media.

Following primary and secondary crushing, lump quartz, sandstone and quartzite for use as flux in the manufacture of silicon and ferrosilicon, etc., must be screened to meet size specifications. Screening may result in minor upgrading through removal of impure fines, but such material is essentially used as quarried with no beneficiation apart from sizing.

Beneficiation

Uses requiring silica in the form of sand or flour, e.g., glass, silicon carbide, foundry and asbestos cement, usually require precise sizing and a high-purity product. Thus, further processing and beneficiation are normally required to both size and upgrade the raw silica feed material.

Further reduction of the silica to a specific size, e.g., minus 850 μm to plus 150 μm, must be carefully carried out to avoid introducing extraneous impurities such as mill iron and other contaminants, and care must be exercised to avoid over-grinding. Whole unfractured grains are preferred in foundry moulding, and fines are detrimental in both foundry and glass sand applications. Over-grinding is more difficult to control when the starting material is quartz or quartzite, which do not possess a well-defined granular structure, than when crushing a more weakly cemented friable sandstone. The choice of grinding unit is also important; for example, impact mills produce more fractured grains and fines than jaw, cone or roll crushers.

Following reduction to the size required, various beneficiation steps may be employed to remove impurities, typically clay, feldspar, carbonates and ferromagnesian minerals. Beneficiation can include one or more of the following:

1. Screening to remove the coarse and fine fractions, which usually contain a significant percentage of the total impurity.

2. Magnetic separation to remove iron-bearing minerals.

3. Jigging or tabling to remove heavy minerals.

4. Attrition scrubbing and washing to remove clay and slimes.

5. Flotation to remove minerals that do not respond to magnetic or gravity methods, e.g., feldspar and pyrite.

6. Acid leaching to further reduce iron and carbonate minerals.

CONCERNS

Health and Safety

Crystalline silica is silicon dioxide (SiO_2). Most mined minerals contain some SiO_2. “Crystalline” refers to the orientation of SiO_2 molecules in a fixed pattern. The three most common crystalline forms of silica encountered in industry are quartz, tridymite and cristobalite.

Silicosis is a disabling, non-reversible and sometimes fatal lung disease caused by overexposure to respirable crystalline silica. Silicosis can be prevented when crystalline silica is used safely and appropriate precautions are taken. Silicosis is preventable if employers, workers and health professionals work together to reduce exposures (source: U.S. Department of Labor, Occupational Safety & Health Administration). In the United States, any mineral product with a crystalline silica content of >0.1% may be regulated under the U.S. Occupational Safety & Health Administration Hazard Communication Standards (see www.osha.gov/SLTC/silicacrystalline/).

In Canada, the Workplace Hazardous Materials Information System (WHMIS) (see www.hc-sc.gc.ca/hecs-sesc/whmis/) is Canada's hazard communication standard. WHMIS is implemented through coordinated federal, provincial and territorial legislation.

Recycling

The use of recycled glass (cullet) is still increasing, which in turn is reducing the need for virgin raw material in the glass batch. The second largest use for recycled container glass is as a feedstock for insulation fibreglass manufacture (up to 40% of the feed). Silica sand used in abrasive blasting is usually single pass as it is cheap and breaks down rapidly during use. The reclamation and re-use of foundry sands are on the increase due to escalating purchasing and disposal costs.

Environment

Except for temporarily disturbing the immediate area while mining operations are active, sand and gravel mining usually has a manageable environmental impact.

OUTLOOK

The demand for foundry sand (source: USGS) is dependent mainly upon automotive and light truck production levels that parallel GDP growth. Sales of glass are expected to vary from market to market (e.g., flat glass and specialty glass). The demand for quartz crystal devices is likely to continue to increase; thus, quartz crystal production will probably remain strong.

Over the long term, glass demand has been growing at around 3.5%/y, which is a lighter rate than GDP (source: Pilkington). The demand for value-added products is growing at a faster rate than demand for basic glass. These value-added products are becoming increasingly important in the automotive market, delivering greater functionality to a vehicle's glazing.

The Freedonia Group forecasts that U.S. demand for advanced flat glass will increase at 6.5%/y and reach US$6.7 billion in 2008. Increased demand will be driven largely by the introduction and commercialization of new products, specifically smart glass products, self-cleaning window glass, and heads-up display wide screens for motor vehicles. More mature product lines, such as low-emissivity solar control glass and automotive safety glass, will continue to dominate overall demand, but will record slower growth.

The silicon (source: Roskill) that is used in the aluminum, chemical and electronics industries is expected to show growth in demand of about 6%/y over the next four years, with silicon chemicals being the fastest-growing sector in volume. Ferrosilicon demand depends upon demand for cast iron. Market growth for ferrosilicon is expected to be less than 1.5%/y up to 2007, but demand for steel will exceed 2%.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 64. (2) Information in this review was current as of April 29, 2005. (3) This and other reviews, including previous editions, are available on the Internet at www.nrcan.gc.ca/mms/cmy/com_e.html.

TARIFFS

Item No.	Description	Canada			United States	EU	Japan
		MFN	GPT	USA	Canada	Conventional Rate (1)	WTO (2)
2505.10	Silica sand and quartz sands	Free	Free	Free	Free	Free	Free
2506	Quartz (other than natural sands): quartzite, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape						
2506.10	Quartz	Free	Free	Free	Free	Free	Free
2506.21	Quartzite: Crude or roughly trimmed	Free	Free	Free	Free	Free	Free
2506.29	Quartzite: Other	Free	Free	Free	Free	Free	Free
2804.61	Silicon containing by weight not less than 99.99% of silicon	Free	Free	Free	Free	Free	Free
2804.69	Silicon, other	5%	3%	Free	Free	5.5%	Free
2811.22	Silicon dioxide	Free	Free	Free	Free	4.6%	3.3%
2849.20	Silicon carbide	Free	Free	Free	Free	5.5%	3.3%
7202.21.10	Ferro-silicon containing by weight more than 55% but less than 60% of silicon	Free	Free	Free	Free	5.7%	Free
7202.21.20	Ferrosilicon containing by weight 60% or more of silicon but less than 90%	Free	Free	Free	Free	5.7%	Free
7202.21.30	Ferro-silicon containing by weight 90% or more of silicon	Free	Free	Free	Free	5.7%	Free
7202.29	Ferro-silicon, other	Free	Free	Free	Free	5.7%	2.5%
7202.30	Ferro-silico-manganese	Free	Free	Free	Free	3.7%	2.5%
7202.50	Ferro-silico-chromium	Free	Free	Free	Free	2.7%	2.5%

Sources: Canadian *Customs Tariff*, effective January 2005, Canada Border Services Agency; *Harmonized Tariff Schedule of the United States,* 2005; *Official Journal of the European Union* (October 30, 2004 Edition); *Customs Tariff Schedules of Japan, 2004*.
(1) The customs duties applicable to imported goods originating in countries that are Contracting Parties to the General Agreement on Tariffs and Trade or with which the European Community has concluded agreements containing the most-favoured-nation tariff clause shall be the conventional duties shown in column 3 of the Schedule of Duties. (2) WTO rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. SILICA, CANADIAN PRODUCTION AND TRADE, 2002-04

Item No.		2002		2003		2004 (p)	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
PRODUCTION (Shipments)							
	By province						
	Newfoundland and Labrador	x	x	x	x	x	x
	Nova Scotia	x	x	x	x	x	x
	New Brunswick	x	x	x	x	x	x
	Quebec	534 817	16 519	474 865	13 241	599 000	17 071
	Ontario	479 016	10 999	532 999	12 239	500 547	12 494
	Manitoba	x	x	x	x	x	x
	Alberta	221 871	8 444	342 350	9 455	339 348	9 373
	British Columbia	x	x	x	x	x	x
	Total	1 539 878	45 398	1 581 120	41 707	1 690 352	46 552
EXPORTS							
2505.10	Silica sands and quartz sands						
	United States	239 113	7 528	311 845	6 850	641 770	11 378
	Italy	41	14	224	52	4 694	475
	South Korea	–	–	1 626	107	271	175
	Venezuela	–	–	–	–	6 353	117
	China	–	–	866	14	190	78
	Israel	–	–	358	8	5 009	63
	Spain	84	28	189	57	106	51
	Belgium	–	–	–	–	208	48
	Japan	57	21	52	33	108	46
	Saint Pierre and Miquelon	–	–	–	–	120	22
	Czech Republic	–	–	–	–	66	19
	Portugal	–	–	4	. . .	52	13
	Malaysia	–	–	–	–	3 437	12
	Russia	–	–	–	–	50	10
	India	–	–	–	–	34	10
	Germany	–	–	–	–	46	9
	Jamaica	–	–	–	–	44	9
	Norway	18 562	707	9 631	381	2 485	7
	Barbados	–	–	62	2	21	6

TABLE 1 (cont'd)

Item No.		2002		2003		2004 (p)	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)							
	Brazil	–	–	–	–	20	6
	South Africa	–	–	–	–	18	5
	Chile	6 000	9	34	16	18	4
	Cuba	1	...	–	–	110	3
	Taiwan	–	–	–	–	9	2
	Trinidad and Tobago	7	4	–	–	7	2
	Netherlands	–	–	–	–	42	1
	Bahamas	–	–	–	–	20	...
	Guyana	–	–	–	–	2	...
	Hong Kong	–	–	2	...	2	...
	Ireland	–	–	–	–	3	...
	Greece	1	...	7	...	12	...
	Turkmenistan	–	–	–	–	4	...
	Switzerland	–	–	20	...	–	–
	United Kingdom	–	–	74	17	–	–
	Uzbekistan	–	–	20	40	–	–
	Peru	–	–	19	4	–	–
	New Zealand	–	–	444	85	–	–
	Australia	200	41	1 883	737	–	–
	Honduras	–	–	10	...	–	–
	Finland	–	–	12	2	–	–
	Saint Kitts and Nevis	20	4	1	...	–	–
	Nicaragua	–	–	14	...	–	–
	France	66	13	–	–	–	–
	Total	264 152	8 369	327 397	8 405	665 331	12 571
2506.10	Quartz (other than natural sands)						
	United States	4 889	1 201	21 493	875	6 148	976
	China	–	–	–	–	5 200	241
	Germany	–	–	98	6	168	11
	France	–	–	–	–	118	9
	Japan	20	3	8	1	51	4
	Bulgaria	153	55	720	111	–	–
	Hong Kong	250	31	–	–	–	–
	New Zealand	–	–	740	48	–	–
	Total	5 312	1 290	23 059	1 041	11 685	1 241
2506.21	Quartzite, crude or roughly trimmed						
	United States	1 131	390	1 606	578	1 374	489
2506.29	Quartzite, n.e.s.						
	United States	75	27	97	20	42	21
	Cuba	135	13	343	34	–	–
	Total	210	40	440	54	42	21
2811.22	Silicon dioxide						
	United States	274	1 081	289	1 514	302	958
	Switzerland	25	2	500	79	1 223	165
	Hong Kong	1 876	178	69	16	709	136
	United Kingdom	118	22	166	16	846	113
	Japan	100	20	207	20	833	66
	Netherlands	–	–	38	4	259	40
	Thailand	–	–	–	–	112	24
	Ireland	–	–	–	–	87	17
	Romania	–	–	–	–	186	15
	Jamaica	82	8	–	–	128	12
	Germany	–	–	...	23	109	11
	Israel	–	–	20	4	77	9
	Taiwan	–	–	145	89	100	9
	Italy	–	–	–	–	89	8
	South Africa	–	–	–	–	84	8
	France	–	–	–	–	77	7
	Chile	25	7	–	–	55	5
	Belgium	–	–	–	–	53	5
	Denmark	–	–	–	–	50	5
	China	–	–	–	–	19	2
	Egypt	–	–	–	–	21	2
	Mexico	–	–	11	1	26	2
	South Korea	–	–	29	3	24	2
	Russia	–	–	–	–	10	1

TABLE 1 (cont'd)

Item No.		2002		2003		2004 (p)	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)							
	Ukraine	–	–	–	–	...	1
	Philippines	–	–	32	6	3	...
	India	–	–	–	–	...	...
	Singapore	–	–	35	3	–	–
	Swaziland	–	–	441	83	–	–
	Brazil	–	–	200	27	–	–
	Kazakhstan	–	–	1	...	–	–
	Total	2 500	1 318	2 183	1 888	5 482	1 623
	Total exports	273 305	11 407	354 685	11 966	683 914	15 945
IMPORTS (1)							
2505.10	Silica sands and quartz sands						
	United States	591 216	44 859	820 309	44 581	1 241 927	42 389
	Australia	608	509	1 095	964	29 702	1 888
	Germany	1 102	714	1 373	736	2 202	736
	Venezuela	–	–	56	55	388	351
	Belgium	2 472	123	4 477	153	6 755	234
	Sweden	348	215	523	285	4 220	214
	Netherlands	223	127	307	154	3 233	77
	Poland	5	6	61	49	93	64
	Norway	–	–	–	–	1 222	57
	United Kingdom	39	3	12	5	48	47
	France	2	1	6	1	16	31
	China	195	138	220	75	190	14
	Russia	–	–	–	–	5	5
	Canada	7	2	40	1	271	5
	Mexico	5	...	1	...	1	4
	Italy	3	1	11	4	212	3
	Austria	338	35	10	4	14	2
	Sri Lanka	–	–	45	...	88	1
	Ireland	–	–	–	–	...	1
	Hong Kong	...	...	–	–	5	1
	New Zealand	–	–	–	–	4	...
	Mongolia	–	–	–	–	2	...
	Denmark	–	–	–	–	1	...
	Armenia	–	–	–	–	...	...
	Taiwan	7	...	5	...	1	...
	Ukraine	–	–	2	2	1	...
	United Arab Emirates	–	–	–	–	...	...
	Brazil	4	...	1	...	...	...
	Switzerland	1	...	–	–	–	–
	Thailand	1	...	1	1	–	–
	Chile	–	–	10	...	–	–
	Finland	–	–	...	...	–	–
	Iceland	–	–	21	16	–	–
	Argentina	1	...	1	...	–	–
	Philippines	38	11	1	1	–	–
	Namibia	7	5	–	–	–	–
	Japan	7	2	4	1	–	–
	Iran	1	...	–	–	–	–
	India	106	33	148	43	–	–
	Dominican Republic	1	...	–	–	–	–
	South Africa	227	72	354	90	–	–
	Total	596 964	46 856	829 094	47 221	1 290 601	46 124
2506.10	Quartz (other than natural sands)						
	Spain	4	...	19	50	23 752	1 500
	Italy	37	2	144	10	1 302	696
	United States	8 535	437	6 737	365	6 691	389
	Brazil	2 306	134	2 094	99	1 730	140
	Egypt	–	–	18	1	518	60
	China	30	1	2	...	544	45
	Germany	2 047	112	343	24	206	27
	India	283	15	56	3	450	26
	Switzerland	61	2	23	1	80	1
	Madagascar	–	–	3	...	22	1
	Azerbaijan	–	–	–	–	12	1
	Taiwan	–	–	–	–	2	1
	Tanzania, United Republic of	–	–	–	–	15	1
	Japan	9	...	–	–	1	...
	Mexico	1	...	–	–	2	...
	United Kingdom	10	1	2	...	1	...

TABLE 1 (cont'd)

Item No.		2002		2003		2004 (p)	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
IMPORTS (1) (cont'd)							
	France	–	–	6	...	1	...
	Hong Kong	–	–	2	...	1	...
	Sweden	–	–	4	...	3	...
	Belgium	–	–	–	–	5	...
	Chad	–	–	–	–	2	...
	Austria	5	...	–	–	–	–
	South Africa	10	1	–	–	–	–
	Ireland	–	–	22	1	–	–
	Nepal	–	–	3	...	–	–
	Thailand	–	–	1	...	–	–
	Total	13 338	705	9 479	554	35 340	2 888
2506.21	Quartzite, crude or roughly trimmed						
	United States	1 781	354	1 633	281	2 913	442
	Israel	–	–	174	8	708	137
	Brazil	44	7	82	19	173	39
	Italy	2	...	–	–	156	36
	Madagascar	5	1	–	–	24	5
	India	25	4	–	–	–	–
	China	–	–	7	1	–	–
	Spain	–	–	64	4	–	–
	Total	1 857	366	1 960	313	3 974	659
2506.29	Quartzite, n.e.s.						
	United States	1 086	91	2 363	174	1 609	124
	United Kingdom	26	2	422	28	466	35
	Brazil	741	48	948	43	262	18
	South Africa	24	2	36	3	116	9
	China	15	1	95	6	82	6
	India	185	16	29	2	202	5
	Mexico	24	2	7	...	26	3
	Germany	–	–	291	15	52	3
	Japan	1 266	106	759	44	29	2
	Madagascar	3	...	76	5	15	1
	Peru	5	...	3	...	15	1
	Spain	2	...	–	–	11	1
	Russia	–	–	7	...	20	1
	Morocco	5	...	15	1	3	...
	Uruguay	3	...	15	1	1	...
	Australia	–	–	6	...	4	...
	Congo	–	–	–	–	1	...
	Czech Republic	–	–	–	–	8	...
	Poland	–	–	–	–	2	...
	Ukraine	–	–	–	–	1	...
	Italy	72	4	–	–	–	–
	Argentina	–	–	2	...	–	–
	Canada	–	–	2	...	–	–
	Colombia	–	–	8	1	–	–
	France	–	–	126	12	–	–
	Lebanon	–	–	1	...	–	–
	Total	3 457	272	5 211	335	2 925	209
2811.22	Silicon dioxide						
	United States	22 202	47 641	23 384	44 623	25 545	43 180
	Germany	1 080	6 466	1 361	7 636	1 406	8 037
	China	1 115	2 580	1 140	2 629	1 690	2 331
	United Kingdom	61	241	197	1 525	251	2 225
	Japan	182	985	271	1 183	268	1 086
	Switzerland	107	736	87	774	64	667
	Italy	1	7	6	15	57	125
	Venezuela	48	81	44	40	122	124
	Turkey	–	–	–	–	55	63
	Sweden	3	24	9	54	16	54
	Singapore	71	98	6	64	57	50
	Russia	–	–	–	–	24	45
	Canada	6	18	2	20	9	37
	Netherlands	3	9	15	35	15	35
	Ukraine	–	–	1	6	3	24
	Ireland	2	13	3	19	5	17
	Norway	728	283	82	116	9	12
	France	61	103	23	46	2	10
	Brazil	2	7	–	–	3	9

TABLE 1 (cont'd)

Item No.	2002		2003		2004 (p)	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
IMPORTS (1) (cont'd)						
South Korea	...	3	1	6	1	7
Hong Kong	...	1	5	19	1	4
Mexico	771	1 072	...	2	1	4
India	–	–	...	...	1	4
Belgium	134	351	16	35	...	3
Chile	–	–	–	–	1	3
Taiwan	...	1	...	1	1	2
Finland	–	–	–	–	...	1
Denmark	1	2	...	...	...	...
Australia	–	–	–	–	...	...
Israel	...	2	–	–	–	–
Austria	...	...	–	–	–	–
Lithunania	–	–	...	1	–	–
Albania	...	...	–	–	–	–
Total	26 578	60 724	26 653	58 849	29 607	58 159
Total imports	642 194	108 923	872 397	107 272	1 362 447	108 039

Sources: Natural Resources Canada; Statistics Canada.
– Nil; ... Amount too small to be expressed; n.e.s. Not elsewhere specified; (p) Preliminary; x Confidential.
(1) Includes sand for use in foundries and glass manufacturing, ground and flour sand, and volatized and silica flue dust.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, IMPORTS OF SILICA SAND FROM OTHER COUNTRIES, BY PROVINCE AND BY USE, 2002-04

	2002		2003		2004 (p)	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
FOUNDRY (1)						
Nova Scotia	–	–	91	1	–	–
New Brunswick	989	21	2 509	37	2 759	59
Quebec	34 421	992	39 709	808	50 864	1 099
Ontario	353 168	9 931	596 517	9 137	477 733	9 799
Manitoba	45 931	1 196	53 026	809	25 739	549
Saskatchewan	3 638	93	2 035	49	1 752	33
Alberta	30 517	792	8 869	143	2 000	55
British Columbia	18 530	481	2 306	37	3 339	54
Total	487 194	13 508	705 062	11 022	564 186	11 646
GLASS MANUFACTURING (2)						
Nova Scotia	164	98	233	92	3 097	70
New Brunswick	–	–	–	–	54	2
Quebec	106	58	1 616	573	36 457	793
Ontario	23 416	2 050	32 593	1 223	15 096	406
Manitoba	132	7	37	23	446	16
Alberta	125	9	13	6	108	2
British Columbia	155	50	35	19	380	9
Total	24 098	2 272	34 528	1 935	55 638	1 296

Sources: Natural Resources Canada; Statistics Canada.
– Nil; (p) Preliminary.
(1) Foundry refers to HS code 2505.10.00.10 (2) Glass manufacturing refers to HS code 2505.10.00.20
Note: Numbers may not add to totals due to rounding.

TABLE 3. REPORTED USE (1) OF SILICA IN CANADA, BY INDUSTRY, 2001-03

	2001	2002	2003 (p)
		(tonnes)	
Nonferrous smelting and refining	989 863	953 064	735 914
Primary glass and glass containers, and glass fibre wool	515 207	517 495	497 476
Foundries	290 806	258 768	244 977
Chemicals	75 800	82 185	85 655
Other products (2)	713 993	790 821	933 655
Total	2 585 669	2 602 334	2 497 677

Source: Natural Resources Canada.
(p) Preliminary.
(1) Available data, as reported by users. (2) Includes abrasives, asbestos products, asphalt roofing products, cement (construction), ceramic products, structural clay products, cleansers, fertilizers, paint and varnish, pulp and paper products, refractory brick, rubber products, ferroalloys, primary steel and other miscellaneous products.

TABLE 4. SILICA, REPORTED QUANTITY USED (1) IN CANADA, 2001-03

	2001	2002	2003 (p)
		(tonnes)	
Sand	1 636 017	1 711 312	1 659 889
Lump	838 544	836 590	767 821
Flour	111 108	54 431	69 967
Total	2 585 669	2 602 334	2 497 677

Source: Natural Resources Canada.
(p) Preliminary.
(1) Available data, as reported by users.