Silica

Michel A. Boucher

The author is with the Minerals and Metals Sector, Natural Resources Canada.
Telephone: (613) 992-3074

SUMMARY

The demand for silica (SiO_2) remained relatively flat in Canada in 1995. The recycling of container glass continued to increase. Demand for container glass was good until the middle of the year but declined during the second half. Fibreglass producers have recently started using recycled flat glass, and also use more of their own rejects. Demand for flat glass that is related to the construction and the automobile industries continued to be weak. Because the steel industry performed well in Canada and the United States, the demand for both ferrosilicon (Fe-Si) and silicon carbide (SiC) was very good. The production of silicon (Si) for the aluminum and steel industries was also good.

SUPPLY

Nova Scotia

Shaw Resources, a member of The Shaw Group Limited, produces a high-purity silica from sand deposits located near Shubenacadie. The silica is used mainly in sandblasting, as foundry sand, and as filter sand. In addition, fines from its silica operation are beneficiated to flint glass-grade material.

New Brunswick

Atlantic Silica Inc. mines a large unconsolidated high-grade (+99% SiO_2) silica deposit near Sussex. The company produces lump silica and silica sand of various sizes. Fine sand products are sold in the Maritimes, Quebec, and the northeastern United States for use in sandblasting, filter sand, traction sand, cement and concrete manufacturing, refractory use and decorative sand, and as a flux for base-metal smelters; the sand could also be used in glass-making. The lump silica and coarse-grained sand can be used in the production of silicon metal and silicon carbide.

Newfoundland (Labrador)

Shabogamo Mining and Exploration Ltd. continued exploration on its high-purity quartzite deposits near Labrador City. The samples analyzed to date indicate silica ranging from 99.3% to 99.9%.

Quebec

Unimin Canada Ltd., a subsidiary of Unimin Corp. of the United States, is the largest producer of silica in Quebec. Silica is mined from a quartzite deposit at Saint Donat and from a sandstone deposit at Saint Canut. Silica from Saint Donat (100 000-t/y capacity) is refined at the Saint Canut plant near Montréal. Most of the silica produced by Unimin Limited originates from Saint Canut where the ore is crushed, screened and beneficiated by magnetic separation. The production capacity of the Saint Canut plant is about 550 000 t/y of finished products. Most of Unimin's output is used in the production of glass containers, flat glass, fibreglass, and in the silicon carbide industries.

Baskatong Quartz Inc. produces high-purity lump quartz from a quartzite deposit north of La Malbaie that is owned by SKW. The silica is used mainly by SKW Canada Inc. at Bécancour for the production of ferrosilicon and silicon metal, and by Elkem Métal Canada Inc. at Chicoutimi. Baskatong continued production of a small high-purity quartz vein deposit at Ste-Edwidge in the Eastern Townships of Quebec. Also during the year, and following a year of development, the quarry at St-Ludger re-opened to produce high-purity quartz.

Armand Sicotte & Sons Limited mines Potsdam sandstone at Sainte-Clothilde, south of Montréal. The company's lump silica is used mainly in the production of ferrosilicon and in the cement industry. The material could be used in the production of glass if market conditions improve.

The Good Sand Company Ltd. mines silica sand at Saint-Joseph-du-Lac and at Ormstown. The material is used mainly for sandblasting and as concrete sand, and is suitable for the production of fibreglass.

Temisca Silice Inc. of Saint-Bruno-de-Guigues produces silica for use in sylviculture, filtration, sandblasting, foundries, golf course sand, and as traction sand.

Ressources Vogue continued exploration on a high-purity quartzite deposit near Fermont. Proven reserves of 923 000 t of silica and probable reserves of 324 000 t of silica have been delineated. The quartzite is reported to grade 99.62% SiO_2, 1063 parts per million (ppm) Al_2O_3, 366 ppm Fe_2O_3, 176 ppm CaO, and 44 ppm TiO_2.

Syquartz of Trois-Rivières started commercial production of standard-quality synthetic quartz in early 1995. The plant has a production capacity of 40 t/y. Initially, high-purity quartz (lasca) will be imported. Synthetic quartz is used to manufacture oscillators, resonators and filters in communications equipment, computers, lasers, optical equipment, and for other applications.

Ontario

Unimin Canada Ltd. is also the largest producer of silica in Ontario, with a reported total capacity of about 550 000 t/y. Lump quartzite from Badgeley Island (150 000-t/y capacity) in northern Georgian Bay is shipped by lake boat to Canadian destinations for the manufacture of ferrosilicon. The finer material, produced by crushing, 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.

Hutcheson Sand & Gravel Ltd. mines an unconsolidated silica sand in the Muskoka area. The sand is used mainly as golf course sand and for other industrial uses.

Saskatchewan

Hudson Bay Mining and Smelting Co., Limited (HBMS) produces silica from one pit in the Amisk Lake area of northern Saskatchewan, while a second pit is on standby. The silica is used by HBMS as a smelting flux at its copper-zinc smelter in Flin Flon, Manitoba.

Red Deer Silica Inc. produces a small amount of silica northeast of the village of Hudson Bay, Saskatchewan. The main market is for golf course bunkers.

Alberta

Sil Silica, a wholly owned subsidiary of The Warren Paving and Materials Group Ltd., produces silica sand from local sand dunes in the Bruderheim area. The silica is sold mainly for the manufacture of fibreglass and as sandblasting material. It is also sold as foundry sand, filtration sand, fracturing sand, and railway traction sand. The company also produces silica flour by processing the silica sand through a ball mill; the flour is used in thermal cement in the oil and gas industries.

British Columbia

Mountain Minerals Co. Ltd. mines a high-purity, friable sandstone deposit near Golden. At a plant near Golden, the ore is crushed, screened, washed, dried and separated into several sizes. These different sizes are sold mainly as glass sand, but also as sandblasting sand, foundry sand, filter media sand, and golf course sand. In addition, the company produces lump silica that is used in the production of silicon.

Bert Miller Inc. mines the Nicholson silica deposit located about 11 km from Golden. The property is owned by Silicon Metaltech Inc., a producer of silicon metal with a plant at Wenatchee, Washington. The ore consists of a massive quartzite and is sold as lump material.

TRADE

Most silica sand imported into Canada comes from loosely consolidated and easily processed sandstones or lake sand deposits located near the Great Lakes. Major U.S. operations are located in the states of Illinois, Wisconsin, Michigan and Indiana. The imported silica sand is used mainly by iron and steel foundries and by the glass industry of Ontario and Quebec. In 1995, imports of silica sand for use in foundries were 373 596 t valued at $12.03 million; in 1992 they were 315 191 t valued at $5.89 million, while in 1990 they were 589 162 t valued at $8.99 million. In 1995, imports of silica sand for use in glassmaking were 189 841 t valued at $2.94 million; in 1992 they were 101 230 t valued at $0.995 million and in 1990 they were 152 028 t valued at $1.49 million.

OUTLOOK

Environmental concerns and the disposal problems posed by plastic containers should encourage greater use of glass containers, which are easier to recycle. However, the glass container industry continues to increase its recycling, which results in a reduction in the consumption of silica and other industrial minerals used in glass-making. Also, on the negative side of silica usage, automotive glass glazing and small pieces of plastic glazing are now in use and are expected to increase in popularity over time. Markets for flat glass and fibreglass are not expected to improve as long as the economy remains weak. On the positive side, producers of silicon carbide, ferrosilicon and silicon metal, which have suffered for many

years because of low prices and low profitability, should see their situation improve.

In the longer term, competition from U.S. producers of silica for glass and foundry sand will remain strong in Ontario and Quebec because of the proximity of these provinces to the low-cost producers of the Great Lakes region. Imports of cullet (broken glass) from the very large market in the United States will continue, and this will negatively affect Canadian producers of silica. The recycling of silica sand at foundries means that no growth can be expected in the foundry sand industry in Canada. Competition from substitutes for glass containers, such as paper, plastics and aluminum, will remain strong. The consumption of silica in sandblasting should decline as a result of tighter environmental controls and substitution from minerals such as garnet, olivine, staurolite and feldspar. The filler market is still small, but its growth will continue to be strong.

Recycled glass is beginning to enter new markets outside the traditional glass markets. Glass is being used for a variety of other end uses that will negatively impact silica sand markets in the future. Some of these markets include: sandblast abrasives, water filtration, reflective paint, asphalt filler, and non-skid industrial flooring.

The mineral wollastonite, which is composed of SiO_2 and CaO, is being investigated as a source of silica and lime in glass plants. Wollastonite would reduce energy consumption where limestone is calcined during the process. Also, the requirements for silica sand would be reduced.

OPPORTUNITIES

Dow Corning Energy Systems Inc. of the United States indicates that a very important shortage of silicon metal (a product that is electricity intensive) is developing in the Western World. By the year 2000, Dow Corning predicts that an additional 230 000 t/y of silicon metal will be required, and the company reports that there are no silicon plants under construction in the Western World. Canada is in a good position to attract new production facilities, especially in British Columbia, Quebec, Labrador, and possibly Manitoba, because electricity is readily available and very competitive, and high-purity silica is either available or could be recovered from deposits not yet being mined.

The production of silicon carbide (SiC) is also electricity-intensive (7-10 kWh/t SiC), and new production facilities could be built in Canada to supply the U.S. market, which has become very dependent on Chinese imports in recent years. There are only two SiC plants in North America. Elektroschmelzwerk GmbH (ESK) operates a plant at Hennepin, Illinois, in the United States, and Norton (St-Gobain) operates an old plant in Shawinigan, Quebec. Each plant has a production capacity of about 40 000-45 000 t/y SiC.

According to ESK, a large SiC plant with a production capacity of 45 000 t/y, and equipped with a system to recover the gases generated during the process, would be competitive worldwide if electricity was available at a cost of US2.5-3.5¢/kWh. Because SiC is very hard, to crush and micronize crude SiC for use in abrasives, for example, requires almost as much electricity as is required to produce crude SiC. To transport finely crushed SiC costs less than lump SiC. Therefore, crude SiC should be crushed, micronized and classified in Canada before it is exported.

Other high-value silica products could be produced in Canada because of the low cost of electricity in certain parts of the country, including:

- cultured quartz in western Canada for the production of oscillators used in electronics, in optical instruments and other applications;
- fused amorphous silica or quartz (minimum 99.8% SiO_2) in the form of ingots, rods, tubes and powder for the chemical and electronic industries;
- cristobalite for use as filler (infrared anti-block) in plastics, in abrasive paints on roads, as a partial substitute for TiO_2 in paints, and as a refractory product;
- high-purity ground silica (minimum 99.5% SiO_2, 2-20 microns) for use as an abrasive for metal polishes and cleansers, and as fillers in plastics and rubber;
- monocrystalline silicon for the production of silicon chips; and
- chemical-grade silicon metal for the production of silicones in western Canada.

With the exception of a recently built cultured quartz plant in Quebec, none of these products are currently produced in Canada.

In addition, there are opportunities for:

- integrated silicon carbide plants in both eastern and western Canada, based on local raw materials and inexpensive electricity;
- a new reinforcement fibreglass plant (in Canada, there is only one plant in Ontario);

- **the production of silicones[1] by reacting silicon metal powder with methyl chloride;**
- **the production of fumed amorphous silica[1] from the hydrolysis of silicon tetrachloride[2] in a flame of hydrogen and oxygen for use in rubbers; as a thickening agent in inks, paints, cosmetics, etc.; for use in polyester; and in specialty coatings such as powder coatings;**
- **precipitated silica and silica gel[1] by reacting sodium silicate[3] with sulphuric acid. (These products are used for reinforcing rubber, in tooth-pastes, as extenders in paints, as fillers in inks, and as thickener in batteries.)**

REFERENCES

[1] No production facility exists yet in Canada, although most raw materials are available.

[2] Produced through the chlorination of silicon metal or silica.

[3] Produced by reacting high-purity silica with sodium carbonate.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 70. (2) Information in this review was current as of January 31, 1996.

TABLE 1. CANADA, SILICA PRODUCTION AND TRADE, 1994 AND 1995

Item No.		1994		1995p	
		(tonnes)	($000)	(tonnes)	($000)
PRODUCTION	(shipments)				
	By province				
	Newfoundland	–	–	..	..
	Prince Edward Island	–	–	..	..
	Nova Scotia	x	x	..	..
	New Brunswick	x	x	..	..
	Quebec	603 983	15 312 751	..	..
	Ontario	884 589	10 997 032	..	..
	Manitoba	–	–	..	..
	Saskatchewan	x	x	..	..
	Alberta	115 974	5 130 910	..	..
	British Columbia	x	x	..	..
	Total	2 053 794	39 874 930	..	..
IMPORTS[1]					
2505.10	Silica sands and quartz sands				
	United States	1 161 441	26 498	1 245 502	27 722
	Australia	1 215	454	5 162	569
	Norway	2 136	248	5 475	401
	Belgium	12 169	83	4 390	82
	South Africa	23	7	1 687	193
	Other countries	2 914	243	323	195
	Total	1 179 898	27 536	1 262 539	29 170
2506.10	Quartz (other than natural sands)				
	Spain	77 870	3 105	15 055	854
	United States	3 870	276	3 649	257
	Brazil	883	65	1 156	86
	Belgium	134	10	–	–
	Other countries	3	...	1 638	98
	Total	82 760	3 457	21 498	1 299
2506.21	Quartzite crude or roughly trimmed				
	United States	1 668	181	1 204	213
	Brazil	–	–	24	5
	Total	1 668	181	1 228	218
2506.29	Quartzite n.e.s.				
	United States	864	108	621	58
	France	209	30	320	46
	Other countries	228	33	343	50
	Total	1 301	172	1 284	156

TABLE 1 (cont'd)

Item No.		1994		1995p	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)					
2811.22	Silicon dioxide				
	United States	11 564	25 475	12 595	24 766
	South Korea	2 218	1 047	3 677	1 938
	France	2 203	3 398	2 214	4 164
	Germany	2 097	4 690	1 870	4 431
	Other countries	22	215	229	1 294
	Total	18 104	34 830	20 586	36 597
EXPORTS					
2505.10	Silica sands and quartz sands				
	United States	157 402	1 158	164 534	1 462
	Bermuda	17 213	159	–	–
	Cuba	7 418	34	42	7
	Other countries	583	145	1 172	161
	Total	182 616	1 500	165 748	1 633
2506.10	Quartz (other than natural sands)				
	Bulgaria	–	–	300	35
	United States	294	272	155	79
	United Arab Emirates	–	–	94	7
	Total	294	272	549	122
2506.21	Quartzite crude or roughly trimmed				
	United States	23 569	314	950	543
	Total	23 569	314	950	543
2506.29	Quartzite n.e.s.				
	United States	90	17	–	–
	Ireland	–	–	21	3
	Taiwan	–	–	17	32
	Total	90	17	38	36
2811.22	Silicon dioxide				
	Hong Kong	60	176	563	1 068
	Taiwan	83	394	117	564
	United States	42	180	95	123
	Other countries	1	45	31	164
	Total	185	798	806	1 922

Sources: Natural Resources Canada; Statistics Canada.
– Nil; .. Not available; ... 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. IMPORTS OF SILICA SAND FROM THE UNITED STATES, BY PROVINCE AND BY USE, 1994 AND 1995

	1994		1995p	
	(tonnes)	($000)	(tonnes)	($000)
FOUNDRY				
Newfoundland	–	–	–	–
Prince Edward Island	–	–	–	–
Nova Scotia	1 000	17	1 490	27
New Brunswick	89	4	82	5
Quebec	22 170	708	25 053	972
Ontario	270 172	6 681	320 673	9 158
Manitoba	3 823	350	3 040	344
Saskatchewan	512	99	255	91
Alberta	91	15	463	74
British Columbia	49 047	939	22 540	1 353
Total	346 904	8 818	373 596	12 026
GLASS MANUFACTURING				
Newfoundland	–	–	–	–
Prince Edward Island	–	–	–	–
Nova Scotia	–	–	–	–
New Brunswick	–	–	–	–
Quebec	221	17	25 680	407
Ontario	108 002	1 482	160 885	2 364
Manitoba	3	1	–	–
Saskatchewan	–	–	–	–
Alberta	–	–	3 178	158
British Columbia	13	7	98	14
Total	108 239	1 508	189 841	2 944

Source: Statistics Canada.
– Nil; p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 3. CANADA, REPORTED CONSUMPTION[1] OF SILICA, BY INDUSTRY, 1993 AND 1994

	1993	1994[p]
	(tonnes)	
Nonferrous smelting and refining	550 166	397 854
Primary glass and glass containers, and glass fibre wool	524 566	593 759
Foundries	324 440	338 240
Chemicals	48 534	56 351
Abrasives	57 370	64 907
Other products[2]	831 955	897 596
Total	2 337 031	2 348 707

Source: Natural Resources Canada.
p Preliminary.
1 Available data, as reported by consumers. 2 Includes asbestos products, asphalt roofing products, cement, 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. CANADA, SILICA CONSUMPTION,[1] 1993 AND 1994

	1993	1994[p]
	(tonnes)	
Lump	1 126 219	1 160 082
Sand	1 150 748	1 079 275
Flour	60 064	109 350
Total	2 337 031	2 348 707

Source: Natural Resources Canada.
p Preliminary.
1 Available data, as reported by consumers.

TABLE 5. FLAT GLASS- AND CONTAINER GLASS-MANUFACTURING PLANTS IN CANADA

Company	Plant Location	Type of Glass
PPG Canada Inc.	Owen Sound, Ontario	Flat
AFG Industries Ltd.	Scarborough, Ontario	Flat
	Saint-Augustin, Quebec	Flat
Consumers Glass, a division of Consumers Packaging Inc.	Scoudouc, New Brunswick	Container
	Pointe-St-Charles, Quebec	Container
	Etobicoke, Ontario	Container
	Milton, Ontario	Container
	Brampton, Ontario	Container
	Hamilton, Ontario	Container
	Lavington, British Columbia	Container

Sources: Natural Resources Canada; Unimin Canada Ltd.

TABLE 6. FIBREGLASS PLANTS IN CANADA

Company	Plant Location	Type of Fibre
Owens Corning Canada Inc.	Candiac, Quebec	Insulating
	Markham, Ontario	Insulating
	Edmonton, Alberta	Insulating
Manson Insulation Inc.	Brossard, Quebec[1]	Insulating
Schuller Canada Inc.	Innisfail, Alberta	Insulating
Graham Fiber Glass Limited	Erin, Ontario	Insulating
Ottawa Fiber Inc.	Ottawa, Ontario	Insulating
Owens Corning Canada Inc.	Guelph, Ontario	Reinforcing

Sources: Natural Resources Canada; Unimin Canada Ltd.
[1] Uses glass marbles imported from the United States.

TABLE 7. TYPICAL BATCH FORMULATIONS FOR FLAT GLASS, GLASS CONTAINERS AND FIBREGLASS

Raw Materials	Percent by Weight	Source of
FLAT GLASS[1]		
Silica sand	60	SiO_2
High-calcium limestone	4	CaO
Dolomitic limestone	15	MgO and CaO
Soda ash	20	Na_2O
Salt cake or gypsum	0.5	Na_2O, CaO and SO_3
Rouge	0.5	Fe Colorant
GLASS CONTAINERS[2]		
Silica sand	60	SiO_2
Limestone	14-18	CaO, MgO
Soda ash	19	Na_2O
Alumina source (feldspar, nepheline syenite or aplite)	4-5	Al_2O_3, Na_2O, SiO_2
Others		
Gypsum and/or barite	1	SO_3, BaO
FIBREGLASS		
Insulating fibre[3]		
Silica	40	SiO_2
Soda ash	10	Na_2O
Feldspar or nepheline syenite	20	Al_2O_3, Na_2O, SiO_2
Borax or ulexite	15	B_2O_3
Dolomite or limestone	15	MgO, CaO
Reinforcing fibre[4]		
Silica	28-30	SiO_2
Boric acid	8-11	B_2O_3
Colemanite	11-17	$CaO.B_2O_3$
Kaolin	26-28	Al_2O_3, SiO_2
Limestone or dolomite	28-31	CaO, MgO
Soda ash	0-1	Na_2O
Specialty glass[5]		
Silica sand	65	SiO_2
Feldspar	11	Al_2O_3, Na_2O, SiO_2
Soda ash	2	Na_2O
Boron compounds	22	B_2O_3

Source: Natural Resources Canada, compiled data obtained from: [1] LOF Glass Company, Toledo, Ohio; [2] Brockway Inc., Brockway, Pennsylvania; [3] Owens Corning Canada Inc.; [4] PPG Canada Inc; [5] U.S. Borax.

TABLE 8. SILICON CARBIDE PLANTS IN CANADA

Company	Plant Location
Norton Céramiques Avancées du Canada Inc.	Shawinigan, Quebec
Treibacher (Canada) Ltd. [1]	Niagara Falls, Ontario

[1] Plant closed indefinitely in March 1995.

Note: The production of one tonne of SiC requires the following raw materials, and the approximate tonnages:

Raw Materials	Tonnes
Silica sand (99.6-99.8% SiO_2)	1.5-1.6
Ground petroleum coke	1.2
Recycled SiC	2.5
Recycled graphite	0.06
Electrical energy	7000-10 000 kWh

Grade	SiC (%)
Abrasive	98-100
Refractory	92-99 (typical is +94)
Metallurgical	85-94

Source: Natural Resources Canada.

TABLE 9. SILICON AND FERROSILICON PLANTS IN CANADA

Company	Plant Location	Product
Elkem Métal Canada Inc.	Chicoutimi, Quebec	Fe-Si
SKW Canada Inc.	Bécancour, Quebec	Si; Fe-Si

Note: The production of one tonne of Si requires the following raw materials, and the approximate tonnages:

Raw Materials	Tonnes
Silica (lump (2-10 cm) quartz, +98% SiO_2)	2.60
Wood chips	1.5-2.0
Petroleum coke	0.50
Low ash coal	0.37
Charcoal	0.25
Pre-baked electrodes	0.10
Electrical energy	13 000 kWh

Source: Natural Resources Canada.

TABLE 10. SODIUM SILICATE PLANTS IN CANADA

Company	Plant Locations
National Silicates Limited	Toronto, Ontario Valleyfield, Quebec