Silica

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SUMMARY

In Canada, preliminary available data, as reported by consumers for 1999, show that silica use was 2.7 Mt, a slight decline of 27 088 t from the previous year. Production, as reported by companies and compiled to date for 2000, was valued at $40.8 million, a minor decline of 4.2% from 1999's total of $41.3 million. Imports were valued at almost $102.9 million for 2000, an 8.3% increase from the 1999 value of $95.0 million. Exports were valued at over $6.9 million for 2000, an increase of 16.9% from $5.9 million in 1999 (Table 1).

The decline in silica use is visible in all major silica-consuming industry sectors (Table 3). The main consuming sectors in 1999, in order of importance, were: primary glass and glass containers, and glass fibre wool (24.4%); nonferrous smelting and refining (18.7%); and foundries (11.3%). The chemicals (2.3%) and abrasives (1.9%) sectors followed, along with the remaining other product sectors combined (41.4%). Sand represents 54.2%, lump, 42.3%, and flour, 3.5% of total silica use (Table 4).

During the last decade, the glass industry experienced a period of rationalization and consolidation with new corporate relationships appearing to adapt to the stiff competition from aluminum, polyethylene terephthalate (PETP) and other plastics, and paper containers, which certainly must have had an impact on production and supply to local markets, especially near the Canada-U.S. border. Similarly, industrial silica sand is one of the fundamental raw materials used by the foundry industry. Foundry sand is very important in applications for silica sand and for metallurgical applications. Silica sand is also used in the metal casting process. Metal castings are used in virtually every industry to produce the majority of molds and cores.

PRICE

The January 2001 edition of *North American Minerals News* reported that silica sand prices (ex-works U.S.A., $/t, f.o.b. plant) were in the range of $12-$25 for foundry sand, dry, bulk, and $14-$26 for glass sand, container. The *Mineral PriceWatch* publication of July 2000 reported that silica sand prices had risen lately due to higher production costs, which resulted in lower tonnages of material being used. *Mineral PriceWatch* also stated that industry sources have suggested that any price increases are unlikely to occur during the second half of 2000.

TRADE

In its 1992 report on *The Economics of Quartz*, Roskill Information Services Ltd. estimated that approximately 10 billion t of silica in various forms are used each year worldwide.

This is a good incentive and opportunity for trade. However, although Canada produced 1.5 Mt of silica in 2000, it is not self-sufficient in silica sand and substantial quantities are imported. Of Canada's total silica imports of 392 743 t for 2000, 90.6% came from the United States, of which 71.1% was silica and quartz sands used in foundries and glass manufacturing.

In 2000, Canada imported 13.1% less silica compounds compared to 1999. Imports fell from 444 171 t to 392 743 t even though their value increased from $95 million to $102.9 million.

Imports from the United States come 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 Canadian iron and steel foundry industries used about 74.5% of those imports from the United States, with most of it going to the provinces of Ontario, Manitoba and Quebec. The Canadian glass manufacturing industries used about 25.5% of the imports from the United States, with most of it going to Ontario, Quebec and Saskatchewan (Tables 1 and 2).

Canada's exports of silica for 2000 totaled 394 499 t, of which 97% went to the United States with silica sands and quartz sands representing the bulk (93%) of them.

Canada exported 394 499 t of silica in 2000, 22.6% more than the 321 878 t exported in 1999. The value of exports also increased 16.9%, going from $5.9 million in 1999 to $6.9 million in 2000.

TRENDS, 1992-2000

Canada's use of silica since 1992 has increased slightly (Figures 1 and 2), a reflection of the increased economic performance of the United States and Canada, especially in recent years. The decline from 1999 could be a result of cautionary demand, recycling, reclamation, price changes, or a combination of these factors. With the exception of 1994, silica sand has always been the principal raw material used, followed by lump and flour material.

Canadian silica production (shipments) seems to have reached a high in 1994 and a reprieve in 1998, but has maintained a slight decline since then (Figure 3). Production in Alberta has increased progressively since 1994 while production in Quebec since 1995 and in Ontario since 1996 has remained relatively flat.

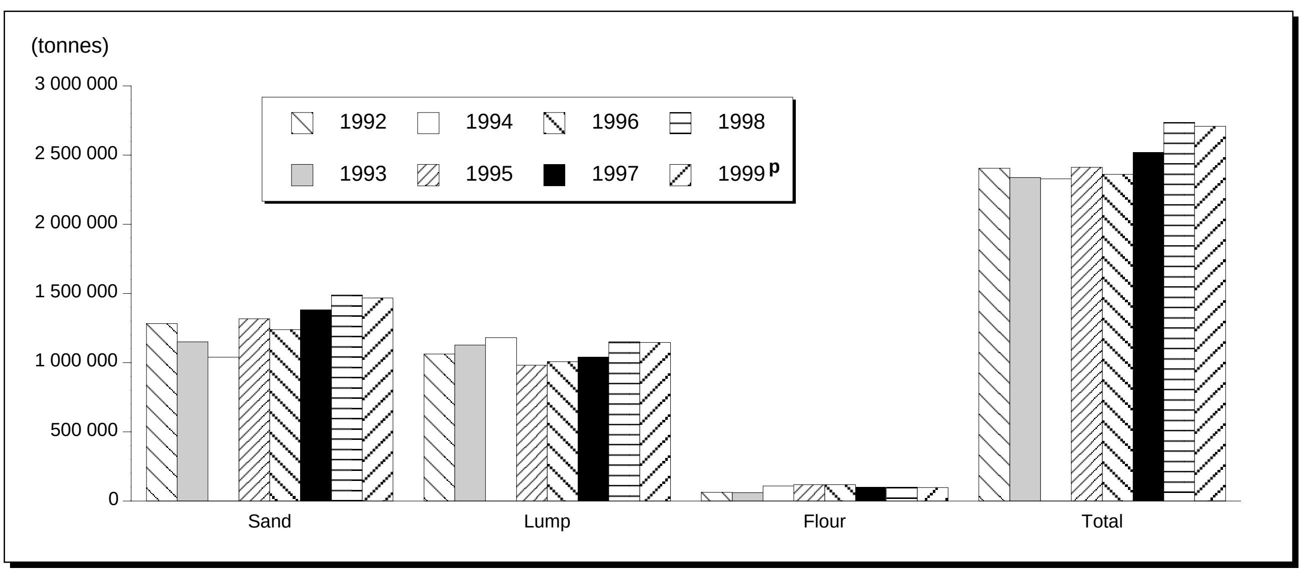
Overall, Canada's value of imports of silica compounds has increased since 1992, and so has the value of exports, although at a slower pace (Figure 4).

PRODUCTION AND MARKET CONSIDERATIONS

Silica (SiO_2) is formed from the two most abundant elements in the earth's crust: silicon and oxygen. Silica is a common mineral, existing in a range of crystalline and non-crystalline forms. Sands, sandstones, quartzites and quartz crystals serve as the basic raw materials for a wide range of applications (Tables 5 and 6), including construction, glass, ceramics, refractories, silicon and ferrosilicon, abrasives, electrical and optical uses. Specialty silica (Table 7) materials are rocks that consist predominantly of silica and are produced as chunks, round pebbles, and sawed or trimmed blocks and other shapes for non-construction applications. The diverse uses of silica and quartz complicate what drives its market. Industrial silica sand has more different uses than any other nonmetallic mineral, mainly due to its common occurrence around the world. Silica sand that is mined and processed for industrial use must conform to the chemical (e.g., purity) and physical specifications set by the customers. Some of the most important physical properties are: grain size and distribution, grain shape (sphericity), grain strength, and refractoriness. Health and safety issues are applied as they relate to crystalline silica (silicosis problems).

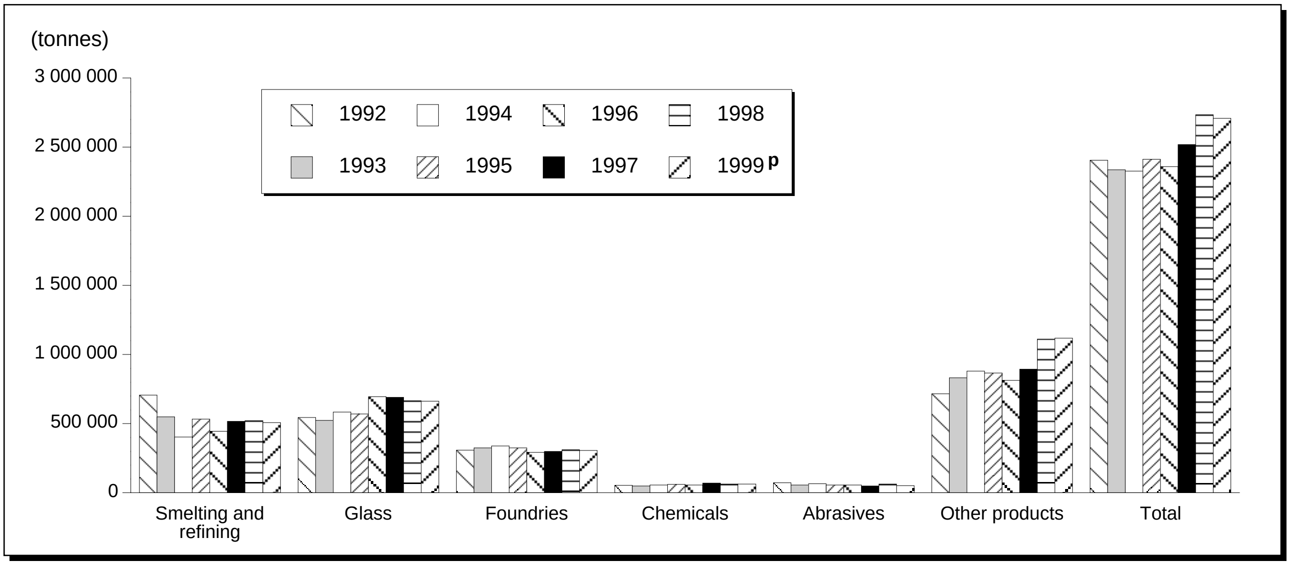
The economics of the production and sale of the many types of silica are governed by many factors, but demand for silica is controlled mostly by the fortunes of the glass and foundry industries. The production of silica is usually a low-price, high-tonnage, very

Figure 1
Silica Used in Canada, by Industry, 1992-99



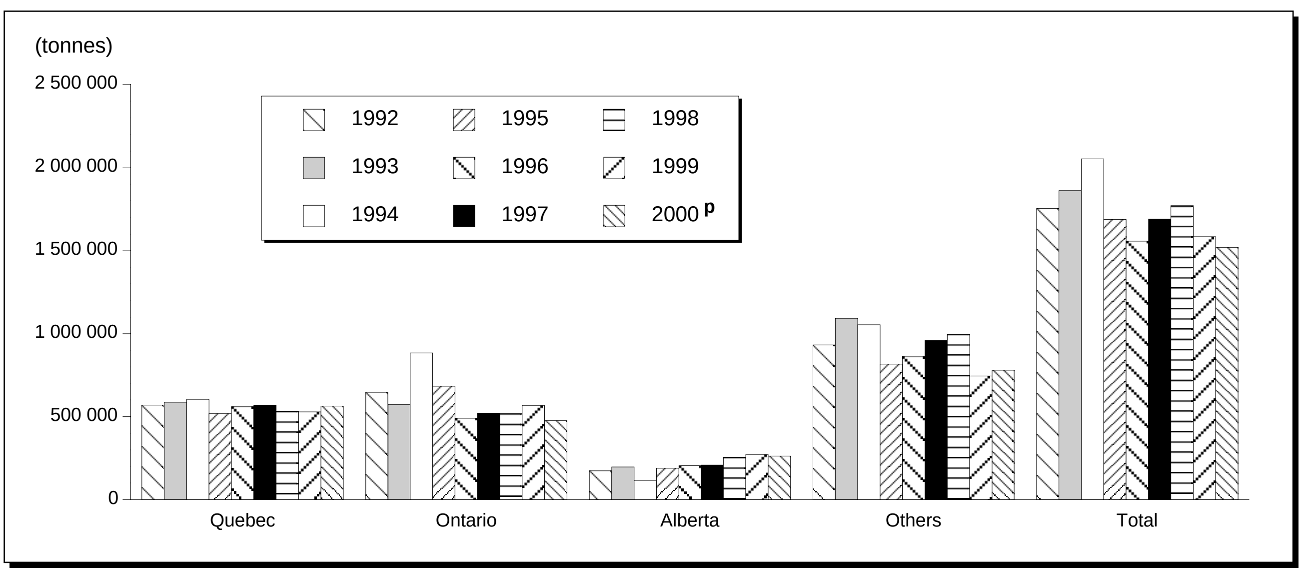
Source: Natural Resources Canada.
p Preliminary.

Figure 2
Silica Used in Canada, by Industry, 1992-99



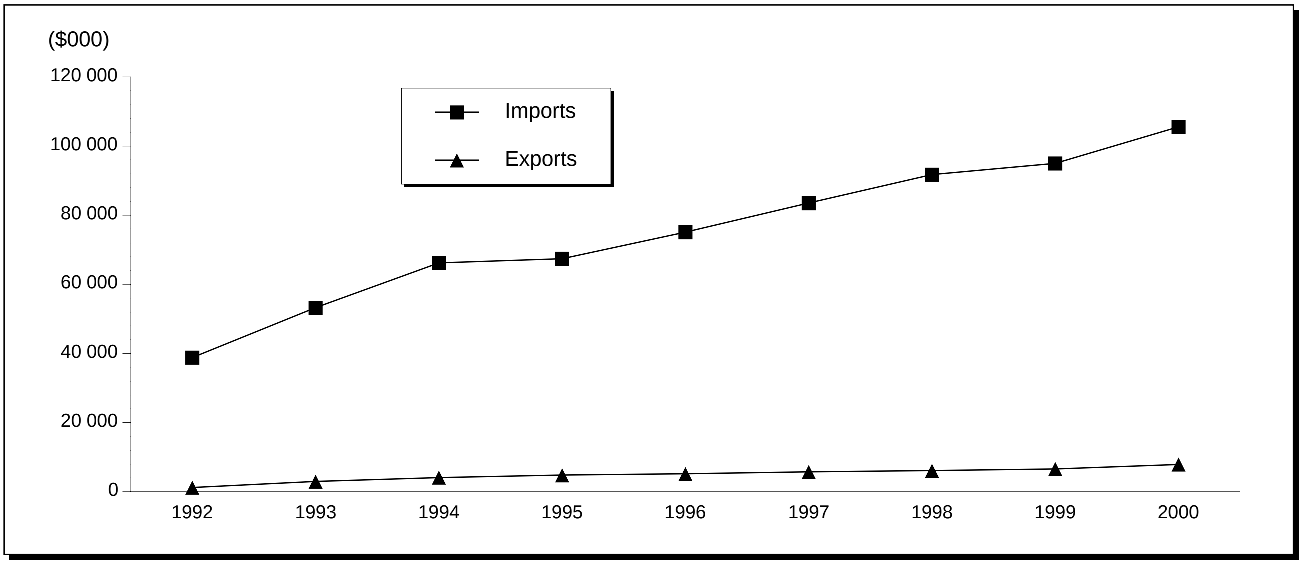
Source: Natural Resources Canada.
p Preliminary.

Figure 3
Silica Production (Shipments) in Canada, 1992-2000



Source: Natural Resources Canada.
p Preliminary.

Figure 4
Silica Canadian Trade of Silica and Silica Compounds, 1992-2000



Source: Natural Resources Canada.
p Preliminary.

competitive operation. Successful operation of a particular silica deposit is dependent upon the ability of the operator to supply consumers with suitable grades (Table 8) of silica at competitive prices. Silica may be obtained from river, lake or sea-side sand deposits by dredging; however, it is generally obtained by open-pit operation of inland deposits. Throughout North America, the silica sand industry is highly competitive on a regional basis and the industry is dominated by a few large producers.

The main modes of transportation to markets are rail, truck, barge and ship. The availability of any one of these transportation methods near a silica sand deposit is essential for a profitable operation. Transporting silica sand is often complex. A silica sand source located substantially closer to its plant can save users hundreds of thousands of dollars per year by reducing transportation costs by only a few dollars per tonne. Lower-priced materials are shipped only to local or regional markets. Prices for actual transactions vary according to geographic region and will take into account the quantity purchased, the application, the quality assurance, the exact grade purchased, the credit terms, and other parameters.

Beneficiation is the key to producing high-quality glass or foundry sand from most deposits. For most applications, the finished sand product must be dried. The following combinations of the processes actually required are a function of the deposit to be mined, the products to be offered, and the markets to be served:

- drying and screening only, which is rarely sufficient;
- washing, drying and screening;
- washing, scrubbing, flotation, drying and screening;
- washing, scrubbing, flotation, drying, screening, and sizing in air separators;
- iron removal (magnetic, wet or dry);
- grinding, regardless of other processes used, if required by the grain size distribution of plant feed;
- acid leaching for high-purity products;
- bagging facilities for some or all products; and
- cooling facilities for foundry sand.

SUPPLY

Canada's silica comes from the Random formation, the Precambrian Bar River Quartzite formation, the Postdam Sandstone (Upper Cambrian) formation, the Winnipeg formation, and some Pleistocene and other formations (e.g., glacial deposits and dune sands).

The distance from the consumer plays a very important role in the delivered price of silica sand. There are many small operations that supply local markets. Some of the most important Canadian producers are described below.

The provinces of Quebec, Ontario and Alberta are the main producers of silica in Canada, followed by Saskatchewan, British Columbia and Nova Scotia. The production (i.e., shipments) of silica in Canada, as reported by producers, was 1 519 706 t in 2000, a decrease of 64 480 t from the previous year. The production value also declined, going from $41.3 million in 1999 to $40.8 million in 2000.

In **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. The official opening ceremony of the operation took place on November 20, 1999. Shabogamo has a contract to supply quartzite to Bécancour Inc. of Quebec, which uses the material to manufacture silicon metal. The first shipment was made in February 2000. The company also shipped three loads of quartzite to Europe for use in the silicon metal industries.

In **Nova Scotia**, Shaw Resources, a member of The Shaw Group Limited, produces a high-purity (98.5-99.5%) silica from sand deposits located near Shubenacadie. The silica is mainly used in sandblasting, as foundry sand and as filter sand. In addition, fines from its silica operation are beneficiated to flint glass-grade material. 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.

In **New Brunswick**, Shaw Resources, Chaleur Silica (a division of The Shaw Group Limited) manufactures abrasive products using raw material from Nova Scotia, Ontario and the United States. It also produces silica for use as a flux at the Belledune lead smelter and for use in cement manufacture.

Atlantic Silica Inc., a subsidiary of Baskatong Quartz Inc. of Quebec, mines a high-grade (+98%) silica deposit near Sussex for use in sandblasting, silicon metal, silicon carbide, foundry sand, filtration sand and ornamental sand. Most of it is used in eastern Canada, although some is shipped to the United States.

In **Quebec**, Unimin Canada Ltd., a subsidiary of Unimin Corp. of the United States, is the largest producer of silica. 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. Most 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.

Bécancour Chemical Industries operates the silica plant in Bécancour that was previously owned by SKW Canada Inc. It also owns the quartzite deposit north of La Mabaie that is being developed by Sitec Inc. Sitec is the newly formed joint venture between Baskatong Quartz Inc., which produces high-purity quartz, and SOQUEM INC., a wholly owned subsidiary of SGF Minéral Inc.

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

Les Sables Silco Inc. mines and grinds its silica at its plant in Sainte-Clothide, Chateauguay County. The products are sold to a chemical company, cement plant and ferromanganese plant.

Temisca inc., which mines and processes silica near Saint-Bruno-de-Guigues, supplies the golf course, filtration, frac, abrasives and construction markets and was recently sold to Stake Technology Ltd. (StakeTech) of Norval, Ontario. The company is particularly interested in developing the frac sand business for the oil and gas industry since the deposit contains an unusually large-grained sand that is normally found only in Texas in the United States.

In **Ontario**, Unimin Canada Ltd. is also the largest producer of silica 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 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.

Other significant producers are: Arriscraft International Inc. with its Elgin Quarry, Damron Minerals with its Ellis Quarry, Great White Minerals Ltd. with its Fripp Quarry, Inco Limited with its Lawson Quarry, and Hunt Engineering Group with its Penhorwood and Roseval quarries.

In **Manitoba**, there are no currently operating silica quarries. Selkirk Silica, based in Selkirk, Manitoba, imports silica sand from Minnesota and packages it for resale. Silica sand and quartz resources are found in southeastern Manitoba and a limited amount of investigation has been carried out by a number of companies (e.g., Gossan Resources Limited).

In **Saskatchewan**, Hudson Bay Mining and Smelting Co., Limited (HBMS) 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. HBMS uses sand as a fluxing agent which, in the molten state, reacts with various impurities in the copper and zinc ore and produces a slag. The slag produced in the smelter, with the impurities, is drawn off, leaving a more refined metal behind.

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, stucco sand and sandblasting sand.

In October 2000, Hanson Lake Silica, a subsidiary of Daren Industries Ltd. of Vancouver, B.C., began processing silica sand from the Winnipeg Formation on the southwestern shore of Hanson Lake, about 100 km west of Flin Flon. The company plans to sell its product to the western Canada frac sand market. Preliminary sizing is done at the quarry to screen out the fines before the sand is trucked about 15 km to a processing plant where washing, drying and final sizing are completed. From the processing plant, the sand will be trucked about 150 km to a distribution facility the company is establishing in Mean Park, north of Prince Albert, Saskatchewan.

In **Alberta**, Sil Silica Inc. of Edmonton, which produces silica sand from local sand dunes in the Bruderheim area, has changed its name to Sil Industrial Minerals Inc. The company operates a silica processing facility near Edmonton. The silica is sold mainly for the manufacture of fibreglass and as sandblasting material. Other uses include 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 insulating cement in the oil and gas industries.

United Industrial Services Ltd. (UIS) of Calgary, Alberta, began operations at its new silica sand plant near Peace River, Alberta, in the summer of 2000. The company's foundry, fibreglass and frac sand, along with the reprocessing of frac sand, are for customers in the northwestern United States and western Canada.

In **British Columbia**, Mountain Minerals Co. Ltd., a division of Highwood Resources Ltd. 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, B.C. 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.

In 2000, Monteith Bay Resources Ltd. supplied 37 000 t of silica to the Tilbury Cement Ltd. plant in Delta from its Monteith Bay quarry on western Vancouver Island.

OUTLOOK

Paul Guttmann, Vice-President of Marketing for U.S. Silica Company, told participants at the Blendon Twelfth Annual Canadian Conference on Markets for Industrial Minerals that the total silica market in North America is well over 30 Mt/y. He stated that Canada and Mexico together account for 15% of silica use while the United States accounts for the remaining 85%.

In addition, Freedonia, in its *U.S. Industry Study on Specialty Silicas* of May 2000, predicted that U.S. demand for specialty silicas will rise by 5.2% per year. That growth will continue to be driven by robust advances in new applications such as chemical mechanical planarization (CMP) slurries, high-performance and/or specialty tire fillers, and ink jet paper coatings. All of these are applications that require precipitated silica and fumed silica.

According to Freedonia, growth will also be driven by stellar gains in tire applications as U.S. producers finally begin larger-scale use of silica as a filler and reinforcement in tires although, for the time being, its success will mainly be in niche markets such as truck tires, winter tires and high-performance tires. Electronics will be the fastest growing market for silica. Gains will result almost entirely from the CMP slurry market, which is growing rapidly due to changes in integrated circuit designs that require smaller and smaller line widths. Sales in this application have nearly tripled since 1994 and double-digit growth will continue through 2004.

In addition, it should be noted that:

- the glass container industry will continue to increase its level of recycling, which will result in a reduction in the use of silica and other industrial minerals used in glass-making;
- the market for flat glass is expected to continue to grow faster than the economy, and the markets for fibreglass (i.e., insulation and reinforcements) are dependent on construction (i.e., housing);
- competition from U.S. silica producers 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;
- the recycling of silica sand at foundries means that no real growth can be expected in the foundry sand industry in Canada; and
- the use of silica in sandblasting should decline as a result of tighter environmental controls and its substitution by other minerals such as garnet, olivine, staurolite and feldspar.

Opportunities

Canada is in a good position to attract new silica production facilities, especially in British Columbia, Quebec, Labrador, and possibly Manitoba, where 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 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.

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, 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 a 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;
- chemical-grade silicon metal for the production of silicones in western Canada;
- integrated silicon carbide plants in both eastern and western Canada, based on local raw materials and inexpensive electricity;
- the production of silicones by reacting silicon metal powder with methyl chloride;
- the production of fumed amorphous silica from the hydrolysis of silicon tetrachloride 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; and
- precipitated silica and silica gel by reacting sodium silicate with sulphuric acid (these products are used for reinforcing rubber, in toothpastes, as extenders in paints, as fillers in inks, and as thickener in batteries).

Other References

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- *Canadian Minerals Yearbook,* Silica chapter, Michel, Boucher, Natural Resources Canada, 1995.
- *Market Trends for Industrial Minerals,* 1997, Natural Resources Canada report.
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- *Silica in Glass*, Paul Guttman, U.S. Silica Company, Paper for the Twelfth Annual Canadian Conference on Markets for Industrial Minerals, October 2000.
- *Silica Sand Trends and Uses in the North American Foundry Industry,* Paul E. Dziekonski, Fairmount Minerals, Paper for the Eleventh Annual Canadian Conference on Markets for Industrial Minerals, October 1999.
- Blendon Information Services.
- *North American Minerals News,* Prices for Silica Sand, January 2001.
- *SME Mineral Processing Handbook,* N.L. Weiss, Volume 2, Chapter 20, p. 18.
- *Industrial Minerals,* February 1984, p. 39.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of June 29, 2001. (3) This and other reviews, including previous editions, are available on the Internet at http://www.nrcan.gc.ca/mms/cmy/index_e.html.

Note to Readers

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2804.61	Silicon containing by weight not less than 99.99% of silicon	8.5%	6%	Free	Free
2804.69	Silicon, n.e.s.	8.5%	6%	2.7%	1.5%-2.7%
2811.22	Silicon dioxide	11.8%	8%	Free	Free
2849.20	Silicon carbide	Free	Free	Free	Free
7202.21.10	Ferrosilicon containing by weight more than 55% but less than 60% of silicon	Free	Free	Free	Free
7202.21.20	Ferrosilicon containing by weight 60% or more of silicon but less than 90%	1.44¢/kg on the silicon content	Free	Free	Free
7202.21.30	Ferrosilicon containing by weight 90% or more of silicon	4.11¢/kg on the silicon content	Free	Free	Free
7202.29	Ferrosilicon, n.e.s.	Free	Free	Free	Free
7202.30	Ferro-silico-manganese	1.44¢/kg or fraction there-of on the manganese content	Free	Free	Free
7202.50	Ferro-silico-chromium	9.5%	6.5%	Free	Free

Sources: *Customs Tariff*, effective January 2001, Canada Customs and Revenue Agency; *Harmonized Tariff Schedule of the United States*, 2001.
n.e.s. Not elsewhere specified.

TABLE 1. SILICA, CANADIAN PRODUCTION AND TRADE, 1999 AND 2000

Item No.		1999 (tonnes)	1999 ($000)	2000p (tonnes)	2000p ($000)
PRODUCTION (shipments)					
	By province and territory				
	Newfoundland	x	x	x	x
	Prince Edward Island	–	–	–	–
	Nova Scotia	x	x	x	x
	New Brunswick	x	x	x	x
	Quebec	528 707	13 785	563 000	13 940
	Ontario	567 208	12 285	477 958	11 630
	Manitoba	x	x	x	x
	Saskatchewan	–	–	–	–
	Alberta	272 189	8 500	262 066	8 450
	British Columbia	x	x	x	x
	Yukon	–	–	–	–
	Northwest Territories	–	–	–	–
	Total	1 584 186	41 349	1 519 706	40 808
IMPORTS[1]					
2505.10	Silica sands and quartz sands				
	United States	361 961	40 023	312 270	44 802
	Germany	1 451	1 222	1 461	804
	China	28	8	548	506
	South Africa	552	316	1 448	410
	Sweden	168	158	491	308
	Other countries	1 419	536	1 345	641
	Total	365 579	42 263	317 563	47 471
2506.10	Quartz (other than natural sands)				
	United States	5 985	319	18 828	1 052
	France	3	. . .	10 725	456
	Spain	42 771	2 086	10 072	423
	Other countries	2 960	153	6 377	283
	Total	51 719	2 558	46 002	2 214

TABLE 1 (cont'd)

Item No.		1999		2000p	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)					
2506.21	Quartzite, crude or roughly trimmed				
	United States	800	171	949	211
	Guatemala	–	–	20	6
	Other countries	10	3	–	–
	Total	810	174	969	217
2506.29	Quartzite n.e.s.				
	United States	1 886	135	2 094	136
	Brazil	772	44	583	49
	Japan	110	7	503	41
	Other countries	1 658	89	128	11
	Total	4 426	275	3 308	237
2811.22	Silicon dioxide				
	United States	19 666	42 062	21 591	41 135
	Germany	846	4 297	1 633	7 647
	Mexico	5	14	1 026	1 677
	China	292	595	259	684
	Japan	318	1 290	107	562
	Other countries	510	1 494	285	1 041
	Total	21 637	49 752	24 901	52 746
EXPORTS					
2505.10	Silica sands and quartz sands				
	United States	311 413	5 029	370 528	4 740
	Norway	9 475	332	9 567	318
	Chile	159	39	147	52
	Other countries	68	17	260	55
	Total	321 115	5 417	380 502	5 165
2506.10	Quartz (other than natural sands)				
	United States	99	104	1 708	459
	Bulgaria	–	–	538	35
	Taiwan	–	–	508	28
	Total	99	104	2 754	522
2506.21	Quartzite, crude or roughly trimmed				
	Norway	–	–	10 250	520
	United States	471	182	673	263
	Total	471	182	10 923	783
2506.29	Quartzite n.e.s.				
	United States	84	17	180	69
	Philippines	23	14	–	–
	Total	107	31	180	69
2811.22	Silicon dioxide				
	United States	25	122	90	340
	Singapore	–	–	3	31
	Other countries	61	61	47	8
	Total	86	183	140	379

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. IMPORTS OF SILICA SAND FROM THE UNITED STATES, BY PROVINCE AND BY USE, 1999 AND 2000

	1999		2000p	
	(tonnes)	($000)	(tonnes)	($000)
FOUNDRY				
Newfoundland	–	–	–	–
Prince Edward Island	–	–	–	–
Nova Scotia	700	12 930	1 000	18 467
New Brunswick	–	–	121	8 186
Quebec	4 854	177 754	26 408	616 885
Ontario	131 254	10 442 471	101 215	10 826 747
Manitoba	28 136	1 224 200	26 717	1 098 726
Saskatchewan	199	65 109	220	87 481
Alberta	14 249	590 607	26 910	1 044 663
British Columbia	11 076	563 205	5 717	369 923
Total	190 468	13 076 276	188 308	14 071 078
GLASS MANUFACTURING				
Newfoundland	–	–	–	–
Prince Edward Island	–	–	–	–
Nova Scotia	152	77 222	298	95 326
New Brunswick	–	–	–	–
Quebec	6 385	728 845	646	136 138
Ontario	104 438	2 573 192	62 768	2 173 250
Manitoba	10	6 031	6	3 275
Saskatchewan	–	–	–	–
Alberta	2 369	127 132	758	28 545
British Columbia	96	36 353	72	59 782
Total	113 450	3 548 775	64 548	2 496 316

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

TABLE 3. REPORTED USE[1] OF SILICA IN CANADA, BY INDUSTRY, 1998 AND 1999

	1998	1999p
	(tonnes)	
Primary glass and glass containers, and glass fibre wool	665 001	662 046
Nonferrous smelting and refining	520 917	506 900
Foundries	310 355	305 858
Chemicals	63 220	62 498
Abrasives	62 773	50 977
Other products[2]	1 112 930r	1 119 829
Total	2 735 196r	2 708 108

Source: Natural Resources Canada.
p Preliminary; r Revised.
[1] Available data, as reported by users. [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. SILICA USE[1] IN CANADA, 1998 AND 1999

	1998	1999p
	(tonnes)	
Sand	1 486 835r	1 467 848
Lump	1 149 326	1 144 408
Flour	99 035	95 852
Total	2 735 196r	2 708 108

Source: Natural Resources Canada.
p Preliminary; r Revised.
1 Available data, as reported by users.

TABLE 5. SOME USES OF QUARTZITE SILICA

most forms of glass	road asphalt enhancer
stone facing	waterproof sewer pipe
car and bike tire additive	building adhesive products
ceramics	water filtration
fibre optics	iron foundries
fibreglass insulation	fibre cement
landscape rock	acid-proof cement
casting of molds	abrasives
grout	water treatment
pool coatings	sand blasting
crystal	home siding
aquarium gravel	absorbent
chemical industry	brick and tile
paint life enhancer	frac drillers sand
golf sand traps	fireproof material

Source: Real Silica Inc. web site (www.silica.org/index.htm).

TABLE 6. PARTICULAR SILICA RAW MATERIALS FOR USE IN SPECIFIC APPLICATIONS (EXAMPLES)

Silica sand

Glass and glass fibre
Silicon carbide
Hydraulic fracturing
Foundry sand
Sodium silicate
Sand blasting and sand paper
Filler media in water treatment
Portland cement manufacture

Lump silica

Flux: massive quartz, quartzite, sandstone, unconsolidated sands
Silicon, ferrosilicon and silicon alloys: lump quartz, quartzite, well-cemented sandstone
Silica brick: quartz, quartzite and garnisher
Aggregate: quartz and quartzite
Lining material in ball and tube mills
Lining and packing for acid towers
Grinding pebbles

Silica flour

Ceramics, enamels, frits, pottery flint
Filler, rubber, asbestos cement
Extender in paint
Abrasive in soap and scouring pads
Autoclave-cured concrete products

Quartz crystal

Electronics for its piezoelectric properties
Fusing quartz

Source: *Industrial Minerals* (magazine), April 1987, p. 25.

TABLE 7. SPECIALTY SILICAS

The processing of silica of specific quality yields several types of specialty silicas. These include colloidal, fumed, fused, high-purity ground, silica gel, and precipitated silica.

- Colloidal silica is mainly used as a high-temperature binder for silicon wafer polishing and carbonless paper.
- Fumed silica, because of its unique strength and thixotropic and flatting properties, is a valuable ingredient in rubber, plastics, specialty coatings, adhesives, cement and sealants; it also aids in manufacturing pesticides, cosmetics, pharmaceuticals, defoamers, inks, abrasives and batteries.
- Fused silica is produced by the fusion of very high-quality silica sand feedstock in electric arc and resistance furnaces. The resulting product is very different from the original silica sand due to its extremely high quality, consistent chemistry, high resistance to thermal shock and low thermal conductivity. It is therefore suitable as a filler for electronic encapsulants, refractory and investment castings, and specialty coatings.
- High-purity ground silica is produced from silica sand or soft, friable rocks and is often referred to as amorphous silica. It is used mainly in specialty coatings, plastics, rubber, electronics, abrasives, refractories and optics, depending on its average particle size, distribution, hardness and refractive index.
- Silica gel is an extremely pure, porous and amorphous form of silica known for its high degree of internal surface area, hardness, uniformity and chemical inertness. Its ability to absorb liquids makes it valuable in a wide variety of applications including catalysts, anticaking agents in food and pharmaceutical products, desiccants, cosmetics, plastics, specialty coatings, paper and adhesives.
- Precipitated silica is another type of specialty silica that is mainly used a a reinforcing agent in tire compounds. Its properties also provide anticaking, conditioning, suspension, and viscosity control in products like toothpastes, deodorants, nail polishes and vitamin tablets.

Current prices for the various forms of these specialty silicas range from $140/t to nearly $6600/t.

Source: Web site, Minerals and Energy Branch, Department of Natural Resources, Government of Nova Scotia.

TABLE 8. SILICA APPLICATIONS, QUALITY AND SPECIFICATIONS

Glass-grade: minimum 98.5-99% SiO_2 with Fe_2O_3 of <0.04% (flat glass), 0.03% (flint container), 0.18% (amber container), and 0.3% (fibreglass), 0.2-1.6% Al_2O_3, with limits on alkalis, colourants (nickel, copper, cobalt) and refractory minerals (chromite, zircon, rutile). First-grade optical glass minimum 99.8% SiO_2, <0.1% Al_2O_3 and 0.02% Fe_2O_3. Sodium silicate feedstock >99.4% SiO_2, <0.03% FeO_3. Ceramic-grade (-200 mesh) >97.5% SiO_2, <0.55% Al_2O_3 and 0.2% Fe_2O_3.

Filtration sand: relatively pure and free of dust, clay, and micaceous or organic matter. Grain shape should be angular or round but should not be elongated or flat. A uniform size is required with a narrow particle size distribution, which is measured by effective size (size of a sieve opening that will just pass 10% by weight of a representative sample) and uniformity coefficient (a ratio of the size of a sieve opening that will just pass 60% of a representative sample of the sand to the size of the sieve opening that will just pass 10% [i.e., the effective size] of the same sample). Frac or proppant sand, well-rounded sand with only minor amounts of impurities such as clay, feldspar and calcite (<0.3% solubility in HCl). Common screen sizes are 3.35 x 1.70 mm, 2.36 x 1.18 mm, 1.70 x 0.850 mm, 0.425 x 0.212 mm, and 0.212 x 0.10 mm.

Foundry sand: (-200 mesh) minimum 98% SiO_2 with limits on CaO and MgO in order to reduce the acid demand value (ADV), which is a measure of the binder required. Particle size may be quantified by the American Foundryman's Society grain fineness number, which is approximately the number of openings per inch corresponding to a sieve that would pass a sand sample if its grain were of uniform size, i.e., the average size of grains in the sample. Flux sand (iron and steel) lumpy >90% SiO_2. Refractory sand 95-99% SiO_2. Ground silica and silica flour <0.10% FeO_3, <0.38% Al_2O_3, <0.10% NaO, <0.10% K_2O. Flour has an average particle size of 60 microns. Both require a brightness of +89%.

Silicon feedstock: >98.5-99% SiO_2, <0.1-1.5% Fe_2O_3, <0.15% AlO_3, no P or As, <0.2% CaO, MgO, and LOI with lumps >2.54 cm in diameter and a minimum softening point of 1700°C and decrepitation point of 950°C; ferrosilicon >98% SiO_2, <0.2% Fe_2O_3, 0.4% Al_2O_3, 0.2% CaO and MgO, and 0.1% P with lumps of 0.32-10.16 cm in diameter; SiC >99.7% SiO_2, <0.05% Fe_2O_3 and Al_2O_3, 0.01% CaO, and 5% moisture; cultured and synthetic quartz Fe, Al, transition elements, alkali content measured in the <100 and even <10 ppm ranges.

Source: *The Industrial Minerals HandyBook*, 3rd Edition, Peter W. Harben, p. 188.