M.A. BOUCHER

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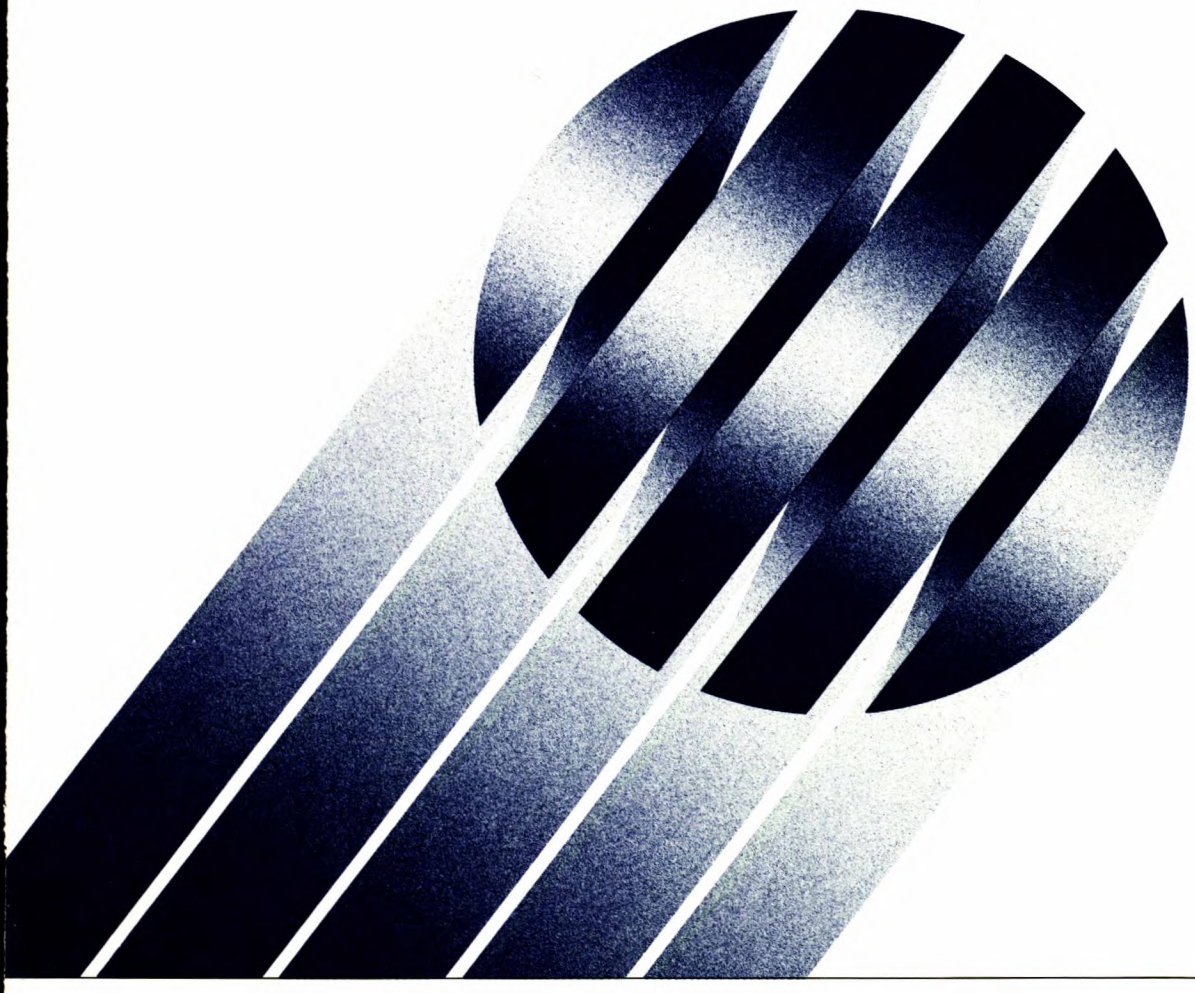
Canada Centre for Mineral and Energy Technology

Centre canadien de la technologie des minéraux et de l'énergie

SUMMARY REPORT NO. 4: SILICA

R.K. COLLINGS AND P.R.A. ANDREWS
Mineral Processing Laboratory

MINERAL SCIENCES LABORATORIES



CANMET REPORT 89-1E

Energy, Mines and Resources Canada
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Canada

THE ENERGY OF OUR RESOURCES - THE POWER OF OUR IDEAS

L'ÉNERGIE DE NOS RESSOURCES - NOTRE FORCE CRÉATRICE

M.A. BOUCHER

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SUMMARY REPORT No. 4: SILICA

by

R.K. Collings* and P.R.A. Andrews**

Abstract

Silica of commercial interest occurs throughout the whole of Canada as vein and intrusive masses and as sand, sandstone and quartzite deposits; and silica mining operations are conducted in all provinces except Prince Edward Island. Silica is recovered in lump form for use as metallurgical flux and in the manufacture of silicon and ferrosilicon alloys; as sand for glass and glass fibre manufacture, for use in foundry moulding, and for the production of silicate chemicals, silicon chips and optical fibres; and as finely ground silica flour for ceramic, asbestos cement and concrete products.

Although Canada is self-sufficient with regard to most of its requirements for silica, significant tonnages of high-quality sand for glass and foundry applications continue to be imported, chiefly by Ontario. CANMET and its predecessor, Mines Branch, have continued to promote interest in domestic silica resources over the years by laboratory research and development studies. These studies have primarily been in the area of beneficiation of submitted samples by a wide variety of mineral processing techniques, and the evaluation of the resulting products for suitability as glass and foundry sand, and for other purposes. This report summarizes no fewer than 115 studies of silica samples undertaken during the period 1923 to 1986. Reference is also made to R&D by other organizations including provincial governments and private sector research laboratories.

Keywords: Silica, Deposits, Processing, Uses, Specifications, Production,Trade, Consumption, Research, CANMET Reports.

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INTRODUCTION

The interest shown by individuals and industry in silica resources of Canada resulted in CANMET, in co-operation with the provinces and industry, undertaking a three-year laboratory study and appraisal of the technical feasibility of producing silica sand for glass manufacture and foundry moulding from province-identified deposits. The study was completed in 1986, and the results are documented in three separate reports(1,2,3).

Correspondence and documents reviewed during that study referenced other silica deposits and investigations considered to be of value. A decision was therefore made to include a further report in the series, namely a summary report of silica in Canada. This present report documents occurrences and deposits of immediate or longer-term interest, lists major uses and specifications for silica, notes production and trade statistics, reviews current developments and activity and, in an appendix, briefly summarizes past research and developments relative to specific deposits. The summarized research is principally research by CANMET and its predecessor, Mines Branch, during the past 50 to 60 years, but research by others is also included.

This is the fourth report in a current *Summary Report* series on industrial minerals. The three previous reports, *Barite*, *Celestite*, and *Fluorite*, are also available.

MODE OF OCCURRENCE

Silica occurs in the free state chiefly as the mineral quartz. Quartz occurs in many forms, the more common being vein and massive intrusive bodies, silica sand, sandstone and quartzite. Quartz also occurs as crystals and as masses or aggregates in 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 usually is restricted to vein or intrusive deposits, and to silica sand, sandstone and quartzite deposits.

Vein and Intrusive Masses

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

Silica sand is sand having a high silica content, e.g., 95% SiO_2 or better. The silica or quartz particles, having been derived from the mechanical disintegration and chemical decomposition of siliceous rocks, are selectively sorted and concentrated by the action of wind or water during transport to new locations where they accumulate to form high-grade deposits.

Fig. 1 – Principal silica deposits in Canada (see legend on the following page and descriptions in Table 1).

LEGEND TO MAP, FIGURE 1

Newfoundland

1. Argentia
2. Fortune, Dunville
3. Hawkes Bay, Highlands of St. John, Dick's Point
4. Diamond Cove
5. La Scie
6. Fermont, "Hill 2907"
7. Hibernia

Nova Scotia

8. Barrington Bay
9. Belmont
10. Brazil Lake
11. Chegoggin Point
12. Elmsvale
13. Diogenes Brook (Melford, River Denys)
14. Leitches Creek
15. Sable Island
16. Fall Brook
17. Hantsport
18. Shubenacadie (West Indian Head)
19. Summerville Beach (Port Mouton)

Prince Edward Island

20. Souris

New Brunswick

21. Sussex (Podiac)
22. Bass River (East Bathurst)
23. Moncton–Saint John
24. Grand Manan, Ross, Nantucket, Whitehead Islands

Quebec

25. Ste. Clothilde
26. St. Canut
27. Val Brillant
28. Melocheville
29. East Templeton
30. St. Donat
31. St. Urbain
32. Guigues (Villa Maria)
33. St. Remi d'Amherst

Quebec (cont'd)

34. Baskatong
35. Magdalen Islands
36. Buckingham
37. Sherbrooke
38. Lac Bouchette
39. Chute aux Outardes (Baie Comeau)
40. Watshishu Hill
41. St. Pascal/St. Andre
42. Pilgrim Islands

Ontario

43–49. Potsdam
50. Joyceville
51. Gananoque (Paddle)
52. Bells Corners
53. Amherstburg
54. Kipling (Missinaibi)
55. Shequiandah
56. Killarney
57. Badgeley Island
58. Kingston–Parry Sound
59. Nelles Corners

Manitoba

60. Black, Punk, Little Punk Hecla, Deer Islands
61. Swan River, Pine River
62. Beausejour
63. Manasan

Saskatchewan

64. Red Deer River
65. Wapawekka Lake
66. Hanson Lake

Alberta

67. Peace River
68. McMurray
69. Bruderheim

British Columbia

70. Golden
71. Canal Flats
72. Valemont

Sandstone

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

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 homogenous mass, are not apparent to the naked eye.

OCCURRENCES AND DEPOSITS

Canada–wide silica occurrences have been documented by L.H. Cole(4,5), A.R. MacPherson(6), and R.K. Collings(7); province–specific deposits have been described by various provincial government and industry officials.

Silica deposits of commercial interest occur in all ten provinces. Many have been explored and developed in past years and a number are in current production. These deposits are located on the map (Fig. 1) and briefly described in Table 1.

Table 1 – Principal Silica Deposits in Canada, by Province

Province and location	Description and development	Typical chemical analyses				References	Map location
		SiO_2	Fe_2O_3	Al_2O_3	L.O.I*		
Newfoundland							
Avalon and Burin peninsulas	A number of multimillion tonne quartzite deposits have been identified in various areas: one near Argentia is under development, another near Fortune has good potential for development. This quartzite is of interest as a potential source of metallurgical flux: the deposit at Dunville is quarried to provide flux for a phosphorous plant at Long Harbour. Potential applications for waste fines include use in portland cement and as sandblast sand.	95–97	0.2–1.7	1.5–3.0	n.d.	10, 11	1, 2
Great Northern Peninsula	As above, with significant occurrences having been identified at Hawkes Bay, Highlands of St. John and Dicks Point. Potential source of flux, but location is remote and development therefore unlikely.	92–98	0.25–0.50	1.0–4.0	n.d.	11	3
Diamond Cove and La Scie	Vein quartz deposits with up to 1 Mt reserves: the La Scie vein on Burlington Peninsula is easily accessible by sea. The potential for overseas markets for use in silica brick is under study.	98–99	0.15–0.30	0.25–1.00	n.d.	11	4, 5

n.d. – not determined
* loss on ignition

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
Newfoundland (cont'd)							
Labrador City	Two silica deposits, "Hill 2907" and "Fermont", were investigated under a Canada/Newfoundland MDA. The former, a tough quartzite, has reserves in excess of 15 Mt; this material would be suitable for use as "lump" silica. The latter, a friable quartzite/sandstone has reserves in excess of 3 Mt; this material would be suitable for use as high-purity silica sand. Interest in the Fermont deposit has been expressed by several companies.	97–98	0.25	0.3–0.5	n.d.	12,14,15	6
Hibernia	Offshore, unconsolidated marine sand, round grained and mostly consisting of quartz with minor feldspar, garnet and ferromagnesian minerals. Material is of potential interest as a foundry or construction sand.	n.d.	0.35–0.45	1.0–1.25	n.d.	16	7

Table I – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
Nova Scotia							
Barrington Bay						4–7.26.36	8
	Beach sand, large deposits, well–rounded quartz grains but fine grained; principal impurities include feldspar, carbonates and ferromagnesian minerals. Iron oxide can be reduced to 0.04% Fe_2O_3 by acid leaching but alumina remains essentially unchanged(26).						
	Head sample	81.0	0.90	11.68	0.74		
	Beneficiated product	83.9	0.04	10.76			
Belmont (Dutch Settlement)	Near–surface sand deposits, 10 km northwest of Truro; well–rounded, clear to frosted grains with sub–angular grains in finer sizes; reportedly high in iron and titanium minerals; reserves reported to be 50,000 t in deposit owned by Nova Scotia Sand and Gravel Company. Maritime Cement Company also has a deposit in this area that is worked intermittently for sand additive for Portland cement.	90.5–95.5	0.17–1.52	2.64–4.21	1.69	3.17.20.32. 35.37	9
Brazil Lake (Nine Mile River)	Near–surface sand beds, 4 km north of Nine Mile River. Overburden varies from 2 to 10 m or more in depth, and sand beds are from 12 to 23 m in thickness. Quartz represents 98% of observed minerals and occurs as both single and compound grains which are sub–rounded to angular in shape. Minor minerals include clay, mica, feldspar and ferromagnesian minerals; reserves are estimated at 750,000 t. The quarry is operated periodically by Nova Scotia Sand and Gravel Company, production being sold as sandblast sand, foundry sand and for miscellaneous uses.	99.1	0.14	0.38	0.32	3.17.23.37	10

Table I – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
Nova Scotia (cont'd)							
Chegoggin Point	Quartzite deposit north and west of Yarmouth and extends from the coastline inland for a distance of 18 km to Lake George. Quarried in the 1950s and early 1960s for use in the manufacture of silica brick at Sydney; current interest is for use in silicon and ferrosilicon production; reserves reportedly are between 10 and 20 Mt.	97.1	0.51	0.97	n.d.	4–7	11
Elmsvale (Musquodoboit)	Deposit is located 1 to 2 km south of Elmsvale; quartz associated with clay, silt, lignite and pyrite in formations that vary from 7 to 22 m in thickness. The quartz grains are angular to sub–rounded; associated impurities include iron, mica, clay and heavy minerals. Reserves are reported to be 3.5 Mt. Testwork by the Technical University of Nova Scotia indicated unsuitability as glass sand; recovery of refractory clay appears to be feasible, but there has been no development.	95–98	0.08–0.25	0.06–12.8	n.d.	3,17,21,22,37	12
Diogenes Brook (Melford and River Denys)	Deposit, located 3 km northwest of Melford, consists of sand beds measuring up to 2 m in thickness; the beds are closely associated with clay and lightly covered by glacial drift. Quartz is fine–grained, white to clear and grains sub–rounded to angular; accessory minerals include iron, clay, mica, feldspar, tourmaline, rutile and magnetite. The deposit was operated in the early 1900s for foundry sand and stoneware clay. Work by the Mines Branch in the 1930s indicated good potential for some portions of the deposit as glass and foundry sand. Reserves were recently estimated at 7 Mt grading 95% SiO_2.	93–98	0.2–2.4	0.75–3.2	n.d.	3–7,17,19,24,37	13

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
Nova Scotia (cont'd)							
Leitches Creek	Quartzite which was at one time quarried for use at the Sydney steel plant.	93.3	0.19	1.45	n.d.	4–7	14
Sable Island	Coarse, brown, impure sand with feldspar and ferromagnesian minerals.	96.5	0.08	1.64	n.d.	7,30	15
Fallbrook	Sandstone, fine-grained, high in iron oxide and alumina.	96.0	0.40	3.06	n.d.	31	16
Hantsport	Coarse-grained friable sandstone with high iron oxide and alumina content; bed reportedly is thin with heavy overburden. Investigated as source of glass sand on several occasions, but considered to be uneconomic. Beneficiation studies by CANMET(29) resulted in a significant improvement in the quality of sand:					6,7,27,29	17
	Head sample	96.3	0.92	1.61	n.d.		
	Beneficiated product	99.5	0.03	0.40	n.d.		
Shubenacadie (West Indian Road)	Sand deposit operated by Nova Scotia Sand and Gravel Company, principally for brick manufacture; reserves reportedly in excess of 1 Mt.	99.1	0.14	0.38	0.32	3,17,33,34	18
Summerville Beach (Port Mouton)	Large deposits of beach sand, rounded quartz grains but fine-grained; principal impurities include feldspar, carbonates and ferro-magnesian minerals. Beneficiation studies by CANMET(28) resulted in significant improvement in quality but low recovery(35%):					4–7,25,28,36	19
	Head sample	79.7	2.64	7.68	n.d.		
	Beneficiated product	99.4	0.09	0.33	n.d.		

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses				References	Map location
		SiO_2	Fe_2O_3	Al_2O_3	L.O.I*		
Prince Edward Island							
Souris	Extensive beach and dune sands extend from Souris to East Point: principally quartz with varying percentages of feldspar and minor ferromagnesian minerals: grains typically are well–rounded. Souris sand has been investigated by CANMET and others as a potential source of glass and foundry sand and found to be generally satisfactory for the latter application, but mining of beach sand is now prohibited.	95.5	0.20	2.00	n.d.	6.7.38–41	20

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
New Brunswick							
Sussex (Podiac)	Unconsolidated deposit of silica sand with lumps of quartz up to 150 mm size, chief impurity kaolinite. The reserves are extensive, estimated at 20 Mt or more. Deposit is under study by Baskatong Quartz Inc., Montreal, as a source of lump silica for ferrosilicon and sand for glass, silicon carbide, foundry, etc. Investigative work by Lakefield Research, CANMET, and others: sample analyses for the CANMET sample(45) are as follows:					3,42–45	21
	Head sample	95.67	0.23	2.51	n.d.		
	Beneficiated product	99.48	0.04	0.17	n.d.		
Bass River (East Bathurst)	Deposit of silica-rich sandstone grading 95% SiO_2. Deposit is operated by Chaleur Silica Ltd., Petit Rocher, which produces 50,000 to 60,000 t of product annually for use as smelter flux, sandblast sand and for specialty cement production. Reserves are estimated at 500,000 t.	94.9	1.72(Fe)	n.d.	n.d.	42	22
Moncton–Saint John area	Medium-grained sandstone deposits occur throughout this area; some are white and fairly pure.	98.2	0.32	1.38	0.40	42	23
Grand Manan Island	Deposits of fine-grained, relatively pure quartzite with low iron oxide and alumina occur on Grand Manan, Ross, Nantucket and Whitehead Islands.	98.8	0.08	0.35	0.45	7,42	24

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
Quebec							
Potsdam sandstone	Potsdam sandstone deposits as source material for the recovery of high purity silica and silica sand occur in the area to the south of Montreal, at Melocheville, Ste. Clothilde and Howick. Deposits also occur north and west of Montreal, at St. Canut and Ste. Scholastique; and east of Hull in the Gatineau Point – East Templeton area. Many of these deposits were extensively investigated by CANMET and others, and several deposits were developed to the production stage, e.g., St. Canut, Ste. Clothilde, Melocheville and Howick. A deposit of interest near Val Brillant, east of Mont-Joli, is under development. Typical head and product analyses of samples from several deposits, obtained during a recent CANMET study(2), are as follows:					2,4–7,49,50, 52,53,56,57, 65–67,69–77, 79,81–86,88	
	Ste. Clothilde de Chateauguay						
	Head sample	98.08	0.11	0.30	0.61	2	25
	Beneficiated product	99.61	0.048	0.06	0.18		
	St. Canut de Deux-Montagnes						
	Head sample	99.06	0.08	0.23	0.15	2	26
	Beneficiated product	99.36	0.034	0.06	0.15		
	Val-Brillant, Rivière Matane						
	Head sample	99.15	0.038	0.33	0.21	2	27
	Beneficiated product	99.72	0.024	0.07	0.23		
	Other head sample analyses have been reported as follows:						
	Melocheville	98.0	0.30	0.40	0.20	83	28
	East Templeton	98.7	0.56	0.24	0.20	65,66	29

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
Quebec (cont'd)							
St. Donat de Montcalm	Massive friable quartzite with minor white kaolin (less than 5%) occurring in minute vugs throughout the deposit; minor iron staining. Currently mined as a source of glass and silicon carbide sand. Beneficiation studies by CANMET(58) gave results as follows:					46.58	30
	Head sample	95.2	0.100	3.39	n.d.		
	Beneficiated product	99.0	0.015	n.d.	n.d.		
St. Urbain de Charlevoix	Large deposit of white to grey vein quartz, minor mica and feldspar; production and beneficiation studies were carried out in 1965 by Ortech International for Leeds Metal Co. Ltd., Montreal(89).					47.89	31
	Head sample	98.3	0.05	0.60	n.d.		
	Beneficiated product	99.3	0.27	0.64	n.d.		
Guigues (Ville Marie)	White to buff coloured, minus 25 mm to sand–size quartz, sub–rounded in shape and loosely bonded with kaolin and minor muscovite. Typical head and product analyses from a recent CANMET study(2) are as follows:					2,51,63,80	32
	Head sample	94.7	0.23	4.51	0.81		
	Beneficiated product	99.1	0.03	0.49	0.17		
St. Remi d'Amherst	Quartz with intermixed kaolin, operated in the past by Canada China Clay and Silica Ltd. as source of both silica and kaolin; no current development.	97.7	0.44	0.88	n.d.	4–7,54,62	33

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
Quebec (cont'd)							
Baskatong	Quartz deposit. operated in the past by Baskatong Quartz Inc., Montreal. as a source of lump silica for silicon and ferrosilicon manufacture.	99.52	0.026	0.15	n.d.	64	34
Magdalen Islands	Shallow water deposits of sand north–east and south–west of Magdalen Islands; typically composed of 88% quartz. 10% feldspar and 2% shell and ferromagnesian minerals: reserves estimated at 100 Mt. A recent study by CANMET(87) demonstrated feasibility of the recovery of high–purity sand suitable for use in glass manufacture and for foundry purposes. as well as by–product feldspar for use in ceramics. Mining rights are held by Magdalen Silica Sand Inc., Montreal. Typical head and product analyses from the CANMET study are as follows:					87	35
	Head sample	96.1	0.230	2.21	n.d.		
	Beneficiated product (silica)	99.6	0.025	0.20	n.d.		
	(feldspar)	70.0	0.650	15.0	n.d.		

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
Quebec (cont'd)							
Quartz/Quartzites	Deposits of quartz/quartzites are common throughout the south–eastern portion of the province. Some have been investigated as source material for lump silica used as flux, and in the manufacture of silicon and ferrosilicon. Typical deposits and analyses are as follows:					4–7,54,68	
	Buckingham area (quartz/feldspar)	99.0	0.41	0.14	0.20		36
	Sherbrooke	99.0	0.05	0.80	n.d.		37
	Lac Bouchette (south of Lac St. Jean)	99.0	n.d.	n.d.	n.d.		38
	Chute aux Outardes (near Baie–Comeau)	98.7	n.d.	n.d.	n.d.		39
	Watshishu Hill area (north shore of the St. Lawrence, north of Anticosti Island)	99.5	0.06	0.13	n.d.	47	40
	St. Pascal/St. André (south shore of St. Lawrence River near Kamouraska)	95.4	0.35	1.65	0.30	4,6,7,60	41
	Pilgrim Islands (St. Lawrence River, above Rivière–du–Loup)	98.2	0.24	1.34	0.45	4,6,7,48	42

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
Ontario							
Potsdam sandstone	Potsdam sandstone deposits as source material for the recovery of high purity, silica and silica sand generally are confined to the Kingston – Brockville – Ottawa triangle. Many deposits, e.g., Joyceville, Paddle (near Gananoque), Bells Corners, were investigated by CANMET and others, but relatively few deposits were developed to the production stage. Arriscraft Corp., Cambridge, operates a quarry north of Kingston for the recovery of sand used in artificial stone manufacture. Typical head and product analyses of samples from several locations obtained during a 1983 study by CANMET(1) are as follows:					1,4,6,7, 91–93, 96,97, 99–101, 109–113, 115–117, 119–124, 126,132, 133,135, 136	43–52
	Lanark co., Ramsay twp.						
	Head sample	96.86	0.09	0.69	0.65		43
	Beneficiated product	99.50	0.02	0.09	0.27		
	Leeds co., North Crosby twp.						
	Head sample	88.40	0.13	0.39	4.98		44
	Beneficiated product	99.59	0.03	0.08	0.13		
	Leeds co., Bastard twp.						
	Head sample	95.01	0.48	1.00	0.94		45
	Beneficiated product	98.82	0.05	0.36	0.20		
	Leeds co., Elizabethtown twp.						
	Head sample	93.70	0.30	2.10	1.46		46
	Beneficiated product	99.16	0.03	0.09	0.04		
	Frontenac co., Storrington twp.						
	Head sample	98.45	0.13	0.70	0.26		47
	Beneficiated product	99.65	0.03	0.09	0.04		

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
Ontario (cont'd)							
	Frontenac co., Pittsburgh twp.						
	Head sample	95.94	0.30	1.06	0.98		48
	Beneficiated product	99.70	0.02	0.32	0.18		
	Frontenac co., Pittsburgh twp.						
	Head sample	88.50	0.65	1.52	3.71		49
	Beneficiated product	99.36	0.03	0.34	0.08		
	Head samples analyses of other typical deposits are as follows:						
	Joyceville	98.0	0.26	1.00	0.36		50
	Gananoque	96.5	0.51	1.42	0.83		51
	Bells Corners	97.7	0.20	0.74	0.53		51
Amherstburg (Windsor area)	A number of beds of Sylvania sandstone, averaging 2.5 to 3 m in thickness occur at a relatively shallow depth near Amherstburg. This sandstone is white, has well–rounded grains and is quite pure. The chief impurity, limestone–dolomite, is present as a binding agent. Although samples from these deposits have been investigated on occasion by CANMET and others, there is no development at present.	97.0	0.02	0.04	1.39	6.7.90, 92.94, 118.131	53
Kipling twp., Missinaibi River area	Extensive deposits of clay–bonded silica sand occur along the banks of the Missinaibi and Mattagami Rivers in Kipling and Burstall townships, 75 to 150 km northeast of Hearst. This sand is of high purity with sub–rounded to sub–angular grain shape. These deposits have been investigated on a number of occasions by CANMET and others as source material for glass sand as well as kaolin; however, there has been no sustained development to date.	99.70	0.01	0.12	0.12	6.7.92, 129.130	54

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
Ontario (cont'd)							
Georgian Bay–Timiskaming area	Massive deposits of Lorraine quartzite occur in the area extending from the north shore of Georgian Bay through to Timiskaming. Various deposits are operated for the recovery of silica flux. The deposit on Badgeley Island is operated by Indusmin Ltd., producing lump silica for ferrosilicon manufacture, and silica sand for glass manufacture.					4,6,7,92,95, 103–108, 116,127	55–57
	Typical analyses are as follows:						
	Shequiandah	99.2	0.05	0.33	n.d.		55
	Killarney	98.7	0.08	0.80	n.d.		56
	Badgeley Island	n.d.	n.d.	n.d.	n.d.		57
East central portion of province	Deposits of quartz associated with feldspar occur in the area to the west of Kingston toward Parry Sound and northward toward Arnprior and Renfrew. Several of these operated in the past, chiefly as a source of feldspar, but there is no current production.					4,6,7,92	58
Nelles Corners	Oriskany sandstone is exposed at a number of locations in the area between Fort Erie on the east and Hagersville on the west, the most notable being at Nelles Corners west of Cayuga. This sandstone generally is fairly coarse grained with a calcareous bond. Deposits have been operated periodically as a source of glass sand but there is no development at present. Typical head sample analyses are as follows:					4,6,7,92, 99,132,134	59
	Head sample	93.65	0.28	0.22	1.70		
	Beneficiated product		0.24	0.06			

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
Manitoba							
Winnipeg Formation sands (north–eastern Lake Winnipeg)	The high–purity Winnipeg Formation sands are composed of well–rounded grains of quartz cemented with kaolin and limonite. Prominent deposits occur on Black, Punk, Little Punk, Heckla and Deer islands and on the mainland, near Seymourville. Sands from Black and Deer islands were evaluated by CANMET as sources of glass–quality sand. Selkirk Silica, a Division of Marine Transport Ltd., recovers silica from a deposit on the south shore of Black Island for use as glass, foundry and hydro–frac sand, and for other miscellaneous purposes. Typical head and product analyses for Black Island sand are as follows:					3.5.6.7, 137–141	60
	Head sample	97.5	0.10	1.36	0.53		
	Beneficiated product	99.6	0.01	0.22	0.05		
Swan River (west of Lake Winnipeg, north and east of the town of Swan River)	This sand generally is similar to the Winnipeg Formation but not perhaps as pure, analyzing up to 1% heavy minerals. Large reserves are available and of potential interest as a future source of glass–quality sand.					3.138.139	61
	Head sample	97.5	0.40	0.80	0.90		
	Beneficiated product	99.6	0.03	0.06	0.20		

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
Manitoba (cont'd)							
Beauséjour (60 km northeast of Winnipeg)	Believed to have been derived from Winnipeg formation sands; associated with limestone, feldspar, hornblende and pyroxene. Deposit has been operated periodically to recover sand for glass manufacture, for sand–lime brick and as an additive in Portland cement.	75–90	0.40–0.90	n.d.	n.d.	3.138.139	62
Manasan (20 km southwest of Thompson)	Precambrian quartzite deposit operated as a source of flux for the Thompson smelter. Grade averages 80% SiO_2 with minor iron oxide and alumina.					139	63

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
Saskatchewan							
Red Deer River – (18 km east of Armit on the banks of Red Deer River near Saskatchewan/Manitoba border)	Large deposit of high–purity, white, friable sandstone up to 12 m thick, covered by 3 to 6 m of impure sandstone and 3 to 9 m of glacial till. Sand grains rounded to sub–angular shapes. Investigated on several occasions by CANMET and others as source of glass and foundry sand. Deposit under development by Red Deer Silica Inc., as a source of silica sand for glass and foundry sand markets. Typical sample analyses are as follows (149):					3,5,6,7,142, 143,146–149	64
	Head samples (a)	n.d.	0.057	0.87	n.d.		
	(b)	n.d.	0.045	0.67	"		
	Beneficiated products (a)	99.02	0.015	0.20	0.08		
	(b)	99.14	0.013	0.19	0.03		
Wapawekka Lake – (south shore of lake, 200 km north of Prince Albert)	Large deposit of high purity sand/sandstone in 7 to 18 m cliffs. Sand investigated by CANMET and others as source of glass–grade sand but remote location discourages development. Typical product analyses are as follows(150):					5,6,7,144,150	65
	Beneficiated product	97.88	0.16	0.80	n.d.		
Hanson Lake (65 km west of Flin Flon)	Unconsolidated high–purity silica sand similar to that at Black Island, Lake Winnipeg; 3 to 5 m thick and overlaid by a 1 to 2.5 m thick dolomite caprock. Investigated as source of "frac sand" for Holocene Resources, Calgary, in 1978 but no present development because of remote location.					145	66

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
Alberta							
Peace River – (15 km north of town along banks of Peace River)	Large deposits of high–purity sandstone up to 15 m thick overlaid by 10 to 15 m of soil and shale. Quartz grains rounded to sub–angular, impurities include feldspar and minor iron minerals. Deposit was investigated as a source of glass and foundry sand by CANMET but there is no development at present. Typical analyses are as follows(7):					7.151.155	67
	Head sample	98.5	0.25	0.65	n.d.		
	Beneficiated product	99.1	0.07	0.66	n.d.		
McMurray tar sands (northeastern Alberta)	Large tonnages of oil sands development tailings containing fine–grained quartz sand with minor bitumen and mineral impurities. These tailings have been studied by CANMET and others as a possible source of glass sand but there has been no development to date. Typical analyses were as follows(153):					5,7.152–154 156,157	68
	Head sample	95.5	0.35	2.25	1.50		
	Beneficiated product	99.5	0.05	0.40	n.d.		
Bruderheim (35 km northeast of Edmonton)	A dune sands deposit operated by Sil Silica, a division of Strathcona Resources Industries; products include sand for use in fibreglass manufacture, foundry moulding and water filtration etc.					10	69

Table 1 – (Cont'd)

Province and location	Description and development	Typical chemical analyses SiO_2	Fe_2O_3	Al_2O_3	L.O.I*	References	Map location
British Columbia							
Golden (8 km northeast of town, on southwest shoulder of Mount Moberley)	Large deposit of high–purity silica grading from tough quartzite to friable sandstone and sand: rounded to sub–angular quartz grains, minor kaolin– and iron–staining. Several laboratory studies were undertaken by CANMET. Deposit is currently operated by Mountain Minerals Co., Ltd. of Lethbridge, Alberta, for recovery of quality sand for glass, foundry and miscellaneous uses. Typical analyses are as follows(158):					3,10,158,160	70
	Head samples (a)	99.4	0.27	0.07	0.16		
	(b)	99.7	0.04	0.08	0.12		
	Beneficiated products (a)	99.7	0.08	0.03	0.09		
	(b)	99.8	0.02	0.04	0.07		
Canal Flats – (20 km east of village in southeastern B.C.)	Large high–purity quartzitic sandstone deposit, ranging in texture from firmly cemented to friable; natural grain size is minus 600 μm; with minor iron oxide and clay minerals. Laboratory study by CANMET demonstrated good potential as source of glass sand but no current development is reported. Typical analysis(159) is as follows:					159	71
	Beneficiated product	99.2	0.02	0.28	0.18		
Valemount (480 km northeast of Vancouver)	Large deposit of relatively fine sand: principal impurities, mica and feldspar. Operated in the early 1970s by Alba Sands Ltd. (Hillside Mines Ltd.) for recovery of sand for fibreglass, foundry moulding and sand blasting: not operating at present.	82–85	1.3	3.5	n.d.		72

MINING, PROCESSING AND BENEFICIATION

Mining

Commercial silica is obtained from vein quartz, sand, sandstone and quartzite deposits. Mining is usually by 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, and as a finely ground powder, 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 is 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 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–crushing. Whole unfractured grains are preferred in foundry moulding, and fines are detrimental in both foundry and glass–sand applications. Over–crushing 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.

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 requirement, 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 several sizes of silica with general specifications are detailed under the three general size categories stated.

Lump Silica

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 small percentages of impurities such as iron oxide and alumina can be tolerated. Size is generally minus 2.5 plus 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 for ferrosilicon should be 98% and the iron and alumina contents each less than 1%, with total iron oxide and alumina less than 1.5%. Lime and magnesia should not exceed 0.20% each; phosphorus 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 non–metallic ores.

Silica Sand

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 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, 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 phosphorus 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 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 recovery of oil. The sand should be clean, dry and have a high compressive strength. 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 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 65, 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.

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 abrasive 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 rock is low in silica.

Quartz Crystal, Quartz Wafers, Fused Quartz, Optical Fibres

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 metallic elements as low as possible, usually in the ppm range.

A typical specification of silica for optical fibre is as follows:

Chemical Analysis		Size Analysis	
SiO_2	99.98% min.	+200 μm	40.0%
Metal elements		−200 +100 μm	50.0%
or oxides	1.5 to 5 ppm range	−100 + 75 μm	9.0%
		− 75 μm	1.0%

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.

The reader is referred to excellent papers by Griffiths(8), for more detailed information on uses and specifications for silica, and Teicher(9), for information on specialty silica products.

PRODUCERS AND DEVELOPMENT

Current producers of silica and recent developments are described below on a province–by–province basis. Much of the information relating to producers was obtained from the 1987 *Silica Review Preprint* published by the Mineral Policy Sector of Energy, Mines and Resources Canada(10).

Newfoundland

Dunville Mining Company Limited, a subsidiary of Tenneco Canada Ltd., quarries quartzite near Villa Maria, Placentia Bay for use as flux in the manufacture of elemental phosphorus at Long Harbour, 15 km to the north. Annual production averages 150,000 t, and ore reserves are estimated at 3 Mt, grading 95% SiO_2, 1.6% Fe_2O_3 and 2.1% Al_2O_3(11). Waste fines from the Ville Marie quarry, grading 92 to 95% SiO_2, have limited local use in playgrounds and ballparks.

Canada/Newfoundland Mineral Development Agreement (MDA)

A contract was awarded under the Canada/Newfoundland MDA to evaluate two silica prospects, "Hill 2907" and "Fermont", near Labrador City in western Labrador (DSS Report 6–9056, 1986)(12).

Reserves of quartzite at Hill 2907 were estimated at 15 Mt grading 97.5% SiO_2, 0.22% Fe_2O_3 and 0.30% Al_2O_3, and at Fermont, 3 Mt grading 97.9% SiO_2, 0.24% Fe_2O_3 and 0.48% Al_2O_3. Representative samples of the Fermont silica were processed at CANMET to determine the technical feasibility of upgrading this material to glass-sand specifications. Processing included scrubbing and washing to remove adhering clay, and high-intensity dry magnetic separation to remove iron-bearing minerals. The resulting concentrates averaged 99.7% SiO_2, 0.01 - 0.02% Fe_2O_3, 0.03 - 0.09% Al_2O_3 and 0.01 - 0.1% L.O.I. Interest has been expressed by a number of companies to utilize this material for the manufacture of high-value quartz-based products, e.g., silicon chips and optical fibres in Labrador City(13). Potential markets for the silica as well as various silica-based products are identified(14). Interest has also been expressed in utilizing Hill 2907 quartzite for on-site production of silicon and ferrosilicon; the incentive being abundant low-cost hydroelectric power.

Nova Scotia

Nova Scotia Sand and Gravel Limited produces a high-purity sand product from sand deposits in the Shubenacadie area. Production is sold for a variety of purposes including glass and fibre-glass manufacture, as foundry sand, as hydrofrac sand for use in fracturing oil and gas-formations, and for sandblasting.

Canada/Nova Scotia Mineral Development Agreement (MDA)

A contract(17) was awarded under the Canada/Nova Scotia MDA in 1985 to investigate silica resources and potential markets. Five deposits were examined - Brazil Lake, Belmont, Chegoggin Point, Diogenes Brook and Elmsvale. Representative samples from each deposit were sent to CANMET for laboratory study and evaluation as resources of high-purity silica. The results of this study were reported(3). A second contract(18) identified potential markets for silica from Nova Scotia and New Brunswick.

Prince Edward Island

There is no production of glass-grade silica in Prince Edward Island, although interest has been shown on occasion in developing uses for the Souris sand found in the northeastern end of the island(41). Mining of beach sand is now prohibited.

New Brunswick

Chaleur Silica Ltd. quarries silica from a deposit of firmly cemented sandstone located 7 km east of Bathurst. Production is estimated at 60,000 tpa, and is mostly for use as metallurgical flux at the Belldune lead smelter of Brunswick Mining and Smelting Corp. Ltd. Minor quantities of sand are sold as sandblast sand and as an additive in low-alkali cements. Reserves are estimated at 500,000 t grading 95% SiO_2(42).

Baskatong Quartz Inc., Montreal, Quebec, obtains various sizes of silica from a high–grade quartz gravel and sand deposit located about 15 km south of Sussex. The material is washed, sized and sold for use in the production of silicon and ferrosilicon. Beneficiation studies have demonstrated the feasibility of the recovery of glass–grade sand from the sand portion of this deposit(3,45). Reserves are estimated at 22 Mt grading 98% SiO_2.

Canada/New Brunswick Mineral Development Agreement (MDA)

A Canada/Nova Scotia/New Brunswick MDA identified potential markets for silica from New Brunswick and Nova Scotia(18).

Quebec

Falconbridge Limited, the largest producer of silica in Canada, operated quarries at St. Canut and St. Donat, northwest of Montreal. Rock from the two quarries is processed in a mill at St. Canut to provide high–purity sand for use in glass and fibreglass manufacture and in the production of silicon carbide, an artificial abrasive.

Baskatong Quartz Inc. produces high–purity silica from quartzite deposits north of St. Urbain and south of Lac Bouchette, in the Lac St. Jean area, for use in the production of silicon and ferrosilicon metals and alloys. A major customer, SKW Canada Inc. at Becancour, provides fines to Les Entreprises Loma Ltée. of Beauport, who prepare this material for use in silicon carbide manufacture and as sandblast sand.

Uniquartz Inc. quarries silica from a deposit near Saint Jean de Vianney, about 30 km south of Matane and exports most of its production to ferro–alloy markets in Europe. Reserves are estimated at 15 Mt and the company plans to increase production to 300,000 tpa to supply silicon metal, ferrosilicon and glass–sand markets.

Armand Sicotte and Sons Limited mine sandstone at Ste. Clothilde, south of Montreal, for use in the manufacture of ferrosilicon at Beauharnois and phosphorous at Varennes. Fines from the operation are used in the manufacture of Portland cement.

La Compagnie Bon Sable Ltée. mines silica sand and gravel at St. Joseph–du–Lac and at Ormstown, south of Montreal, for use in sandblasting, as foundry sand and in the manufacture of fibreglass insulation.

Ontario

Falconbridge Limited quarries quartzite on Badgeley Island, Georgian Bay for use in the manufacture of ferrosilicon. Fines from this location are shipped to a company–owned plant at Midland where they are further processed to sand for glass manufacture, and silica flour for ceramic and other uses.

Manitoba

Selkirk Silica, which is a division of Marine Transport Limited, obtains high–purity silica sand from a loosely consolidated sandstone deposit on the south shore of Black Island, Lake Winnipeg. The sand is washed, screened and dewatered at a plant on the island and then shipped 130 km by barge to Selkirk, where it is further processed and sold for glass manufacture, foundry use, for use in fracturing oil–bearing formations and for other purposes.

Inco Limited quarries quartzite near Thompson for use as flux in the Thompson nickel/copper smelter.

Saskatchewan

Hudson Bay Mining and Smelting Co., Ltd., Flin Flon, obtains low–grade siliceous smelter flux from local sand pits.

Red Deer Silica Inc. plans to begin production of high–purity silica sand from a loosely consolidated sandstone deposit on the banks of the Red Deer River, 18 km north of Armit. The deposit contains 14 Mt of sand grading 97 to 99% SiO_2. Production will be sold for glass manufacture, for foundry moulding and for miscellaneous purposes.

Alberta

Sil Silica, which is a division of Strathcona Resources Industries Ltd., obtains sand from a dune sand deposit near Bruderheim. This sand is beneficiated and sold for use in glass fibre manufacture, as a foundry moulding sand and for miscellaneous purposes.

British Columbia

Mountain Minerals Co. Ltd. mines a high–purity, friable sandstone/quartzite deposit near Golden. The mined rock is processed by washing and screening and sold for use in glass manufacture, foundry moulding, sandblasting and for other purposes.

PRODUCTION, TRADE AND CONSUMPTION

Canada produces about 2.6 Mt of silica annually; fifty percent of this amount is relatively low–grade lump silica and sand or gravel for use as flux. The remainder is higher purity silica for silicon, ferrosilicon, silicon carbide, glass and fibreglass manufacture.

Canada's production of high–purity sand is not totally adequate for domestic requirements, and about 1 Mt of silica sand is imported annually, chiefly from producers in the northeastern United States. The bulk of imports is used in glass manufacture, for silicon carbide production and by steel foundries.

The glass industry (and glass-sand market) is centred in the Montreal area of Quebec with three glass container plants, and in southern Ontario where there are two flat glass and four container plants. Alberta has one container plant at Redcliff; British Columbia has one at Lavington, and New Brunswick one at Scoudouc. Glass fibre plants are located at various centres across Canada.

The silicon carbide sand market is split between the Shawinigan Falls area of Quebec and the Niagara Falls area of Ontario. The foundry sand market is principally in southeastern Quebec and southern Ontario. The overall annual consumption of sand in these three markets (glass/glass fibre, silicon carbide, foundry) is estimated at 1.4 Mt.

Canada exports lump silica for use in the manufacture of silicon and ferrosilicon alloys to the United States and overseas markets; annual exports are currently estimated at 100,000 t.

Statistical data relative to Canada's production, trade and consumption of silica for 1986 and 1987 are presented in Tables 2, 3 and 4. These data are from the 1987 Silica Review published by the Mineral Policy Sector, Energy, Mines and Resources Canada(10).

CANMET STUDIES

One hundred and sixteen studies of silica deposits were conducted by CANMET and its predecessor, Mines Branch, between 1928 and 1986. All provinces were represented, although the majority of studies were concerned with resources in Ontario and Quebec. The principal purpose of most studies was to assess the deposits as sources of glass sand. Studies conducted by CANMET and other organizations are summarized in the Appendix. A distinction between CANMET studies and studies by other organizations is made in the references.

Scale of Studies

Most studies were conducted on feed material weighing less than 200 kg. Five studies were conducted on material weighing in excess of 9 t as follows:

Location	Weight (t)	Reference
East Templeton, Quebec	9	65
St. Urbain, Quebec	50	89
Manitoulin Island, Ontario	12	106
Bells Corners, Ontario	100	112
Bells Corners, Ontario	250	133

Head Sample Analyses

The silica content of the various samples investigated varied from 45% SiO_2 for Ontario dune sands(114) to 99.53% SiO_2 for silica sand from Golden, British Columbia(160). Most contained at least 90% SiO_2; some containing up to 25% feldspar or kaolin were lower grade at 70 to 90% SiO_2.

Table 2 – Canadian Silica Production (Shipments) and Trade, 1986–87

	1986		1987	
	(tonnes)	($000)	(tonnes)	($000)
Production (shipments), quartz and silica sand				
By province				
Quebec	836 580	17 025	841 760	17 625
Ontario	1 029 506	10 716	1 013 704	11 467
Alberta	x	3 355	x	4 069
Manitoba	x	2 872	x	2 739
Nova Scotia	x	x	x	x
New Brunswick	x	x	x	x
Saskatchewan	128 400	x	163 166	x
Newfoundland	x	1 526	x	1 349
British Columbia	x	1 896	x	1 987
Total	2 640 436	41 640	2 661 903	44 317
Imports[1]				
Silica sand				
United States	1 055 209	20 200	836 367	16 492
West Germany	6	–	60	10
Other countries	–	–	–	–
Total	1 055 215	20 200	836 427	16 502
Silix and crystallized quartz				
United States	318	270	368	355
Japan	30	44	–	–
Other countries	1	2	148	54
Total	349	316	516	409
Silica (incl. silica gel)				
United States	8 742	13 515	9 545	14 779
West Germany	1 049	3 142	699	2 657
Other countries	565	1 143	423	825
Total	10 356	17 800	10 667	18 261
Exports				
Quartzite				
United States	88 393	1 143	60 669	752
Other countries	–	–	–	–
Total	88 393	1 143	60 669	752

Source: Statistics Canada; Energy, Mines and Resources Canada

– Nil;

x Confidential

[1] Includes sand for use in foundries and glass manufacturing, ground and flour sand, volatilized and silica flue dust

Table 3 – Imports of Silica Sand by Province and Use, 1987

Province	Foundry moulding tonnes	Glass manufacture tonnes	Total tonnes
Newfoundland	–	–	91
Nova Scotia	1 354	–	1 627
New Brunswick	174	–	235
Quebec	28 176	2 667	31 766
Ontario	380 584	170 531	708 584
Manitoba	611	–	318
Saskatchewan	120	–	113
Alberta	731	4	1 059
British Columbia	26 176	814	33 465
Total	437 926	174 016	777 258

Source: Statistics Canada
– Nil

Table 4 – Canadian Reported Consumption of Silica by Industries, 1987

	1987
Primary glass and containers, and glass–fibre wool	924 700
Smelter flux	729 715
Foundries	422 973
Chemicals	197 715
Artifical abrasives	120 516
Other products[1]	501 018
Total	2 896 637

[1] Includes asbestos products, asphalt roofing products, cement and concrete products, ceramic and structural clay products, cleansers, fertilizers, frits and enamels, paint and varnish, pulp and paper products, refractory brick, rubber products, ferro–alloys, primary steel and other miscellaneous products

Mineralogy

The mineralogy of most deposits was similar since the most abundant contaminant minerals were feldspar, muscovite, kaolin, ferromagnesian minerals, carbonaceous minerals and pyrite. Silica occurred in several forms as beach sand, silica sand, sandstone and fine-grained quartzite; one deposit investigated was a granite pegmatite from Saguenay, Quebec(68). Several patterns of mineral association occurred; pyrite and carbonaceous minerals in the Potsdam sandstone, heavy minerals and iron oxide minerals in beach sands, and muscovite and kaolin in kaolinized sand. The frequency of occurrence of all identified minerals was as follows:

	Frequency %
Muscovite, feldspar, kaolin	35
Ferromagnesians, pyrite	23
Calcite, hornblende	15
Magnetite, ilmenite	11
Rutile, garnet, dolomite	8
Bitumen, sphene, biotite, zircon	5
Limonite, tourmaline, sericite, pyroxene, magnesite, marcasite, goethite, apatite	2
Shale, barite, gypsum, topaz, graphite, pyrophyllite, kyanite, ankerite, hematite, chlorite	1
	100

Beneficiation

The beneficiation of silica deposits is influenced by economic considerations because silica is a low-priced commodity. Thus beneficiation techniques investigated included sizing, screening, washing, scrubbing, magnetic separation, gravity concentration and flotation. Other techniques included acid leaching, roasting, electrostatic separation and ultrasonic cleaning.

Screening and Sizing

Dry screening and sizing were used mainly as preliminary sorting techniques before detailed beneficiation. Screening separated coarse and fine mica, kaolin and carbonaceous minerals.

Attrition Scrubbing

Attrition scrubbing at 85% solids followed by washing and wet sizing was employed in about 40% of the studies. Scrubbing was sometimes preceeded by mulling at 97% solids, a procedure which aids break-up of clay or carbonaceous-bonded agglomerates. The shearing action of the impeller blades during attrition scrubbing effectively separated clay and carbonaceous minerals from the surfaces of the quartz grains. When the samples were assessed as a source of glass sand, the scrubbed product was wet screened at 600 and 100 μm; in one study size separation was accomplished by hydrosizing(89).

Magnetic Separation

Wet and dry magnetic separation was employed in about 75% of all studies, thus being the beneficiation technique most used. Magnetic separation rejected iron–oxide containing minerals such as magnetite and garnet, and titanium minerals such as rutile and ilmenite. Generally, if these minerals were liberated, the Fe_2O_3 and TiO_2 levels were each successfully reduced to 0.025%.

Gravity Concentration

Wet tabling was used in about 20% of the studies and was the preferred gravity concentration technique, since glass–sand size range is the size range most suitable for tabling. Spiral concentration using the Humphrey's spiral and more recently the Richards spiral was used in five studies. Jigging was used in one study, but at minus 600 plus 100 μm size range, jigging was not efficient(82). Tabling and spiral concentration removed iron oxide and titanium minerals but not as efficiently as magnetic separation. Tabling and spiral concentration were able, however, to remove non–magnetic pyrite.

Flotation

Since the contaminant minerals were usually present in minor or trace amounts, silica samples were normally concentrated by reverse flotation of impurity minerals. Generally, flotation was applied after scrubbing and magnetic separation; flotation was used in about 30% of the studies. A summary of collectors used is presented in Table 5, and of modifiers, in Table 6.

Flotation was based on well established flotation procedures. Thus, pyrite was floated using xanthates at pH 6(1,66), graphite using kerosene at pH 9(1), and calcite at pH 7 using sodium oleate(1,132) and oleic acid(134). Iron oxide minerals unresponsive to magnetic separation were floated using petroleum sulphonate collectors, specifically the *Aerofloat 800* series, at pH 4.0(2,3,160). Mica, feldspar, kaolin and alumino–silicate minerals were floated using cationic collectors. When mica and feldspar occurred in the same sample, mica was floated before feldspar at pH 4 with a primary amine collector(68,149). After mica removal the pH was lowered to pH 3, hydrofluoric acid added as a feldspar activator, and feldspar floated using a fuel oil – primary amine mixture(28,67,149). More recently, feldspar was floated using *Duomeen TDO* (n–tallow – 1,3 – diamino propane dioleate) at pH 2(2,3,87). The advantage of using *Duomeen TDO* is that it is not necessary to pre–activate feldspar with HF. It was stated that in some studies the flotation of contaminant minerals was aided by high–pulp density conditioning with flotation reagents before flotation (1,2,3).

The modifiers and depressants used in the various studies included sodium carbonate, sodium silicate, hydrofluoric acid, fuel oil, copper sulphate and lead nitrate. Sodium carbonate was used as a pH modifier. Sodium silicate served as a slime dispersant and as a depressant for quartz, it also hindered the precipitation of calcium soaps from hard water and so promoted the formation and stabilization of froths. Sodium carbonate also had an inhibiting effect on quartz flotation. Hydrofluoric acid was an activator for feldspar, and fuel oil served as a froth modifier with collecting properties when used with amine collectors. The role of copper sulphate and lead nitrate is not clear. Lead nitrate used with sodium oleate at pH 9.6(103) could possibly serve as an activator, but whether for quartz or feldspar is uncertain. The same activating ability applies to copper sulphate(26,104).

Acid Leaching

Acid leaching, which was used in about 30% of studies, was generally employed where mineral benefication techniques could not reduce iron oxide and alumina to levels acceptable for glass sand. Techniques employed included chlorination, hydrochloric, hydrofluoric and sulphuric acid leaching to reduce iron oxide levels, and sodium hydroxide leaching to reduce alumina and organic matter(188).

Roasting

The removal of pyrite was assisted by oxidation roasting followed by magnetic separation or acid leaching; reduction roasting was followed by chlorination in one study(76). Carbonaceous material was removed by calcination followed by washing(113).

Miscellaneous Techniques

Other mineral beneficiation techniques included electrostatic separation to remove pyrite(84,85), air tabling to remove mica(129), air classification to remove fines following autogenous grinding (29.65,112) and ultrasonic cleaning to remove bitumen from tar sand(156).

Process Performance

Generally, to achieve the 0.025% Fe_2O_3 and 0.15% Al_2O_3 specifications for glass sand, the feed grade was not less than 95% SiO_2. Some notable exceptions were Port Mouton, N.S. beach sand, which was successfully upgraded from 79.68% SiO_2 to 98.44% SiO_2; recovery, however, was only 35%. Although the concentrated sand contained 0.09% Fe_2O_3, a clear glass melt was obtained because ferrous and not ferric iron was present(28). Silica from the Magdalen Islands, Quebec was successfully upgraded from 88% SiO_2 to 99.6% SiO_2 with 0.20% Al_2O_3 and 0.025% Fe_2O_3(87).

In some investigations the iron oxide levels were reduced below the 0.025% Fe_2O_3 level; a summary is presented as follows:

Location	% Fe_2O_3	Reference
Val Brillant, Quebec	0.014	2
St. Donat, Quebec	0.015	58
Saguenay, Quebec	0.008	68
Lake Timiskaming, Ontario	0.013	128
Mattagami, Ontario	0.010	130
Black Island, Manitoba	0.006	140
Red Deer River, Saskatchewan	0.013	149
Golden, British Columbia	0.006	160

Most studies, in addition to washing or scrubbing, employed only magnetic separation with possibly flotation or acid leaching. Three studies – Barrington Bay beach sand(26), East Templeton sandstone(65), and Bells Corners sandstone(112), employed a wide range of beneficiation techniques.

Evaluation for Other Uses

The main end uses, other than glass manufacture, for which various silica samples were assessed included foundry moulding, core sand and sandblast applications. Other uses included silica brick (72,105,108), silicon carbide (78,130), ceramic uses(55), potter's flint(64), silica flour(64,105), concrete aggregate(73), abrasives (113,135) and hydraulic–frac sand(140).

CONCLUDING COMMENT

This report on silica is the fourth in a summary series of reports on industrial minerals in Canada, the first three being Barite, Celestite and Fluorite. It is hoped that the information presented in these and subsequent reports will be useful to all having an interest in industrial minerals in Canada.

A wide distribution of the *Summary Report* series is planned as a means of encouraging interest and further development of the "non–metallics" that are becoming of increasing interest for use in many diverse applications such as, fillers for paint and rubber and, in the high–technology sector, for products such as high–performance plastics, silicon chips, and fibre–optic filaments.

The authors encourage feedback from reports in this series. Comments and suggestions for further R&D will assist CANMET and associated government and industry groups in planning and conducting research on industrial minerals.

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Table 5 – Collectors Employed for the Removal of Contaminant Minerals

Report No.	Fatty acids[1] g/t	Duomeen TDO g/t	Petroleum sulphonates[2] g/t	Primary amines[3] g/t	Xanthates g/t
Nfld–1	–	180	180	–	–
NS–2	n.s.	–	–	–	–
NS–3	–	–	–	100	–
NS–4	–	–	n.s.	–	–
NS–5	–	–	–	750	–
NS–8	–	–	525	–	–
NS–13	–	–	–	n.s.	–
NS–15	–	126	76	–	–
NB–2	–	127	127	–	–
Que–16	–	–	–	–	n.s.
Que–17	–	–	–	–	25
Que–18	–	–	–	300	–
Que–19	–	–	–	500[4]	–
Que–38	–	420	100	–	–
Que–39	–	80	80	–	–
Ont–2	270	–	–	–	–
Ont–6	100	–	–	125	–
Ont–7	–	–	–	250	–
Ont–13	–	–	–	450	–
Ont–14	–	–	–	200	–
Ont–16	–	–	–	200	–
Ont–17	–	–	–	250	–
Ont–35	270	–	–	370	70
Ont–36	1355	–	–	–	–
Ont–38	750	–	200	–	–
Man–3	–	120	120	–	–
Sask–3	–	–	–	450	–
Sask–5	–	185	–	–	–
BC–3	–	177	252	–	–

[1] Oleic acid and derivatives
[2] *Aerofloat 800* series
[3] Tallow and coco amine derivatives
[4] Separate mica and feldspar flotation

n.s. – not stated

Table 6 – Modifiers Employed for the Removal of Contaminant Minerals

Report No.	HF g/t	$CuSO_4$ g/t	Na_2CO_3 g/t	$PbNO_3$ g/t	Fuel oil g/t	Cresylic acid g/t	Na_2SiO_3 g/t
NS–3	–	700	–	–	–	–	–
NS–4	–	–	–	–	500	–	–
NS–5	1200	–	–	–	4500	–	–
NS–8	–	–	–	–	175	–	–
NS–13	n.s.	–	–	–	–	–	–
Que–17	–	–	125	–	–	50	–
Que–18	800	–	–	–	700	–	–
Que–19	600	–	150	–	–	–	–
Ont–6	1250	–	–	100	–	–	–
Ont–7	750	300	–	–	–	–	–
Ont–13	600	–	–	–	1500	100	–
Ont–14	1250	–	–	–	500	–	–
Ont–16	1250	–	–	–	500	–	–
Ont–17	1500	–	–	–	1000	–	–
Ont–38	–	–	–	–	–	–	50
Sask–3	300	–	–	–	500	–	–

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General references: Reports or papers of broad interest but not necessarily specific to one province or to one particular silica deposit.

Province reference: Province-related reports or papers are subdivided into General, CANMET Research and Research by Other Organizations.

Certain references are followed by an appendix identification key in brackets to facilitate locating summaries of these referenced reports in the Appendix, and several general references are also included with CANMET references.

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APPENDIX

SUMMARIES OF CANMET SILICA STUDIES

The appendix principally summarizes a number of CANMET (Mines Branch) laboratory studies conducted over the past 60 years. These studies are arranged by province and in chronological order. They are identified by province and number, e.g., Nfld.–1, N.S.–1, N.B.–1, as well as by reference number. The reference number and appendix identification keys are cross–referenced to facilitate checking. A number of CANMET–associated studies as well as studies by others have also been included.

Newfoundland

Identification : **Nfld. – 1.** (Ref. No. 16)*

Report – Title : BENEFICIATION OF HIBERNIA SAND FROM GRAND BANKS, NFLD.
– Author(s) : P.R.A. Andrews and G.A. Brown
– No. and Date: CANMET, *Division Report* 83–65(IR), 1983.

Sample Description : Four samples of marine sand from the Hibernia oil field consisting of quartz with minor feldspar, garnet and ferromagnesian minerals. The grains were well rounded, about 98% minus 600 μm with negligible minus 150 μm fines and analyzed 1.10 to 1.24% Al_2O_3, 0.33 to 0.42% Fe_2O_3.

Objective : Evaluation as a source of glass sand.

Processing : Flotation and magnetic separation.

Results : Flotation was superior to magnetic separation in lowering iron oxide levels, however, Fe_2O_3 at 0.06 to 0.09% exceeded glass sand specification; alumina was between 0.22 and 0.34% Al_2O_3. Acid leaching could be employed to further reduce the iron impurity.

Potential Use : The beneficiated sand would probably be suitable for foundry moulding purposes, but is not suitable as glass sand.

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* Appendix identification with reference no. in brackets.

Nova Scotia

Identification : N.S. – 1. (Ref. No. 24)

Report – Title : PREPARATION OF SILICA SAND FROM MELFORD (RIVER DENYS) SAND

– Author(s) : R.K. Carnochan

– No. and Date: CANMET, *Ore Dressing Investigation Report* 410, 1930.

Sample Description : Two samples, one coarse (minus 3.4 mm) analyzing 0.31% Fe_2O_3, the other fine (minus 1.7 mm) analyzing 0.19% Fe_2O_3. The grain shape was angular and impurities included light coloured clay, mica, tourmaline, magnetite, garnet.

Objective : Evaluation as glass sand and sandblast sand.

Processing : Washing, magnetic separation, tabling, screening.

Results : Recovery of glass sand from the coarse sample by washing, screening, tabling and magnetic separation was 41%; the iron oxide content was reduced to only 0.07% Fe_2O_3. The finer sample was not suitable as glass sand. Recovery of sandblast sand by washing and screening was 76% for the coarse sand and 83% for the fine fraction.

Potential Use : Suitable as sandblast sand, possibly suitable as glass sand with further beneficiation to reduce iron oxide content.

Identification : **N.S. – 2.** (Ref. No. 25)

Report – Title : TREATMENT OF SAND FROM PORT MOUTON, NOVA SCOTIA
– Author(s) : R.K. Carnochan
– No. and Date: CANMET, *Ore Investigation Report* (unnumbered), 1939.

Sample Description : Fine–grained beach sand, 98.5% minus 840 μm, analyzing 80.9% SiO_2, 0.47% Fe_2O_3, 10.47% Al_2O_3.

Objective : Evaluation as glass sand.

Processing : Screening, tabling, flotation, magnetic separation; flotation reagents included oleic acid, sodium oleate and emulsol X–1.

Results : The iron oxide could not be reduced below 0.15% Fe_2O_3.

Potential Use ; Possibly suitable for manufacturing coloured glass.

Identification : **N.S. – 3.** (Ref. No. 26)

Report – Title : BENEFICIATION OF BARRINGTON BAY BEACH SAND
– Author(s) : H.L. Beer
– No. and Date: CANMET, *Ore Investigation Report* 2093, 1947.

Sample Description : 125 kg of dune sand, 96% minus 500 μm, sub–angular to angular grain shape analyzing 81.02% SiO_2, 0.90% Fe_2O_3, 11.68% Al_2O_3. The principal impurities were mica, kaolin, feldspar, ferromagnesian minerals, ilmenite, rutile and iron–staining on quartz.

Objective : Evaluation as glass sand.

Processing : Pre–screening to minus 500 plus 150 μm, washing, tabling, flotation, magnetic separation, roasting and washing with salt and acid leaching.

Results : Best results were obtained by washing, magnetic separation and acid leaching. Leaching reduced the iron oxide content to 0.04% Fe_2O_3, but the sand at 83.88% SiO_2 and 10.76% Al_2O_3 was still too low grade.

Potential Use : Not suitable as a glass sand.

Identification : N.S. - 4. (Ref. No. 27)

Report - Title : BENEFICIATION OF HANTSPORT SANDSTONE
- Author(s) : H.L. Beer
- No. and Date: CANMET, *Ore Dressing Investigation Report* (unnumbered), 1948.

Sample Description : Sandstone composed of rounded to sub-rounded quartz grains with an unidentified dark mineral impurity.

Objective : Evaluation as glass sand.

Processing : Crushing and sizing followed by flotation.

Results : Iron could not be reduced below 0.09% Fe.

Potential Use : Suitable for manufacturing coloured glass.

Note: Report contains good descriptions of silica uses.

Identification : N.S. - 5. (Ref. No. 28)

Report - Title : BENEFICIATION OF PORT MOUTON BEACH SAND
- Author(s) : H.L. Beer
- No. and Date: CANMET, *Ore Investigation Report* 2501, 1948.

Sample Description : Beach sand, 98.37% minus 600 μm, grain shape subangular to angular, analyzing 79.68% SiO_2, 2.64% Fe_2O_3, 7.68% Al_2O_3. Principal impurities included quartz, feldspar, ilmenite, hornblende, tourmaline, kaolin, biotite, and muscovite.

Objective : Evaluation as glass sand.

Processing : Screening to remove both plus 500 μm and minus 150 μm fractions, washing, magnetic separation, spiral classification, flotation, acid leaching.

Results : The best results were obtained using flotation and magnetic separation resulting in a product analyzing 98.44% SiO_2, 0.33% Al_2O_3, 0.09% Fe_2O_3, but recovery was very low at 35%. A clear glass melt surprisingly was produced with a sand containing 0.13% Fe_2O_3; it was determined that a greater part of the iron was present as Fe^{++} rather than as Fe^{+++}.

Potential Use : Possibly suitable for manufacturing clear glass.

Identification : **N.S. - 6.** (Ref. No. 29)

Report - Title : RECOVERY OF GLASS SAND FROM HANTSPORT SANDSTONE
- Author(s) : A.R. MacPherson
- No. and Date : CANMET, *Ore Dressing Investigation Report* 2524, 1949.

Sample Description : Two samples of sandstone
Lot 1, 10 t up to 30 cm in size;
Lot 2, 10 t analyzing 96.30% SiO_2, 1.61% Al_2O_3, 0.92% Fe_2O_3.

Objective : Evaluation as a source of glass sand.

Processing : Lot 1 – Aerofall milling and air separation of fines to produce a minus 840 plus 150 µm product, magnetic separation and acid leaching.
Lot 2 – Aerofall milling and air separation of fines, followed by screening to produce minus 600 plus 100 µm product, magnetic separation and acid leaching.

Results : Lot 1 – iron oxide was reduced to 0.019% Fe_2O_3;
Lot 2 – final product analyzed 99.48% SiO_2, 0.40% Al_2O_3, 0.03% Fe_2O_3;
Lot 2 was more representative, as it was taken from several areas in the quarry, whereas Lot 1 was from a single location.

Potential Use : Lot 2 was considered acceptable for use in clear glass manufacture.

Identification : **N.S. - 7.** (Ref. No. 30)

Report - Title : RECOVERY OF GLASS SAND FROM SABLE ISLAND SAND
- Author(s) : R.K. Collings
- No. and Date : CANMET, *Industrial Minerals Report* 213, 1953.

Sample Description : 15 kg of coarse, brown sand, 98% minus 840 µm analyzing 0.70% Fe_2O_3, 1.24% Al_2O_3, with 50% of quartz grains exhibiting iron–staining. The principal impurities included minor feldspar and ferromagnesian minerals.

Objective : Evaluation as a source of glass sand.

Processing : Screening to remove plus 840 µm, magnetic separation followed by scrubbing and washing to remove slimes, leaching of scrubbed product.

Results : Beneficiated sand analyzed 0.05% Fe_2O_3 and 0.93% Al_2O_3; acid leaching did not completely remove brown staining.

Potential Use : Not suitable for manufacturing clear glass.

Identification : N.S. - 8. (Ref. No. 31)

Report - Title : RECOVERY OF GLASS SAND FROM FALLBROOK SANDSTONE
- Author(s) : R.K. Collings
- No. and Date : CANMET, *Industrial Minerals Report* 214, 1955.

Sample Description : Fine-grained sandstone, grey in colour and spotted throughout with pyrite and iron oxide staining, analyzing 0.40% Fe_2O_3, 3.06% Al_2O_3.

Objective : Evaluation as a source of glass sand.

Processing : Sample crushed to 420 μm and sized to recover the minus 300 plus 100 μm fraction. The minus 300 plus 100 μm fraction was treated by magnetic separation and one portion of the non-magnetic product was acid-leached, a second portion was subjected to flotation.

Results : Lowest iron oxide analysis, 0.06% Fe_2O_3, was obtained by leaching; lowest alumina analysis, 1.22% Al_2O_3, was obtained by flotation.

Potential Use : Possibly suitable for manufacturing coloured glass, with further beneficiation to reduce to alumina.

Identification : N.S. - 9. (Ref. No. 32)

Report - Title : BENEFICIATION OF SILICA FROM DUTCH SETTLEMENT
- Author(s) : R.K. Collings
- No. and Date : CANMET, *Investigation Report* 58-220, 1958.

Sample Description : 25 kg of clay-coated sand with many agglomerated grains, analyzing 95.54% SiO_2, 0.17% Fe_2O_3, 2.64% Al_2O_3; grain shape angular to sub-angular.

Objective : Evaluation as a glass sand.

Processing : Scrubbing and washing to remove clay slimes, screening to recover minus 840 plus 100 μm size fraction, crushing and recovery of plus 840 μm, dry magnetic separation.

Results : Study indicated that the best approach was screening at 840 μm to recover a minus 840 μm product, followed by reduction of the plus 840 μm oversize with scrubbing and washing of the combined sizes. Recovery of sand grading 99% SiO_2, 0.03% Fe_3O_3, 0.12% Al_2O_3 was 85 to 90%.

Potential Use : Deposit is of interest as a potential source of glass sand for manufacturing clear glass.

Identification : **N.S. – 10.** (Ref. No. 33)

Report – Title : FOUNDRY SUITABILITY OF SHUBENACADIE SAND
– Author(s) : A.E. Murton
– No. and Date: CANMET, *Physical Metallurgical Report* 60–66, 1960.

Sample Description : High–grade silica sand with a rounded to sub–angular grain shape.

Objective : Evaluation as foundry sand.

Processing : Standard mixing, moulding and casting tests.

Results : Sand was suitable for use as a moulding and core sand in iron foundries.

Potential Use ; Suitable for use as a moulding and core sand

Identification : **N.S. – 11.** (Ref. No. 34)

Report – Title : INVESTIGATION OF SHUBENACADIE SAND
– Author(s) : R.K. Collings
– No. and Date: CANMET, *Mineral Processing Test Report* 60–100, 1960.

Sample Description : 25 kg of sand principally composed of well rounded grains of quartz, pink to brown, analyzing 0.28% Fe_2O_3, 2.12% Al_2O_3. The principal impurities included clay, dark ferromagnesian minerals and some iron oxide staining.

Objective : Evaluation as glass and foundry sand.

Processing : Scrubbing and washing to remove fines, dry magnetic separation, acid leaching to remove iron oxide staining.

Results : Beneficiated product analyzed 98.40% SiO_2, 0.04% Fe_2O_3, 0.27% Al_2O_3.

Potential Use : Deposit possibly of interest as source of glass sand for manufacturing clear glass; foundry evaluation showed material to be suitable for moulding and core sand in iron foundries.

Identification : **N.S. - 12.** (Ref. No. 35)

Report - Title : BENEFICIATION OF BELMONT SAND
- Author(s) : R.K. Collings
- No. and Date: CANMET, *Mineral Processing Test Report* 61-50, 1961.

Sample Description : Rounded to sub-angular grains of quartz containing as the principal impurity 25% clay with minor ferromagnesian minerals and some iron staining.

Objective : Evaluation as glass sand.

Processing : Washing to remove clay, screening to separate minus 840, plus 100 μm fraction, magnetic separation.

Results : Product analyzed 99.59% SiO_2, 0.04% Fe_2O_3, 0.29% Al_2O_3; iron oxide and alumina slightly high for use as glass sand.

Potential Use : Suitable for manufacturing clear glass with further beneficiation to reduce alumina by attrition scrubbing.

Identification : **N.S. - 13.** (Ref. No. 36)

Report - Title : BENEFICIATION OF SANDS FROM SUMMERVILLE AND BARRINGTON BAY
- Author(s) : R.A. Wyman
- No. and Date: CANMET, *Mineral Processing Information Report* MPI 62-72, 1962.

Sample Description : Two samples of beach sand:
Summerville - chiefly quartz and feldspar with minor mica and trace magnetite; analyzing 78.18% SiO_2, 1.68% Fe_2O_3, 7.15% Al_2O_3,
Barrington - chiefly quartz and feldspar with minor mica and hornblende; analyzing 81.8% SiO_2, 0.64% Fe_2O_3, 10.20% Al_2O_3, 0.73% L.O.I.

Objective : Evaluation as glass sand.

Processing : Screening, tabling, flotation, magnetic separation and acid leaching.

Results : Typical product analysis for the Summerville sample was 96.3% SiO_2, 0.18% Fe_2O_3 with 20% weight recovery and, for Barrington Bay, 95% SiO_2, 0.14% Fe_2O_3 with 50% weight recovery.

Potential Use : Possibly suitable for manufacturing coloured glass.

Identification	:	**N.S. – 14.** (Ref. No. 37)
Report – Title	:	NOVA SCOTIA SILICA STUDY
– Author(s)	:	Fenco Shawinigan Engineering Ltd., Halifax N.S.
– No. and Date	:	*Canada/Nova Scotia Mineral Development Agreement*; DSS File No. 5–9061, 1985.
Sample Description	:	Five deposits of silica – Brazil Lake (Nine Mile River), Belmont, Chegoggin Point, Elmsvale (Musquodoboit) on the mainland, and Diogenes Brook (Melford) on Cape Breton Island. Samples from each deposit were processed at CANMET for recovery of high purity sand products.
Objective	:	To identify and summarize available information on a number of silica deposits.
Processing	:	Not applicable.
Results	:	Background information on the deposits, including previous laboratory studies, was summarized under a series of headings as follows: ownership, location and access, site description, deposit description, development history, silica quality, reserves, production and treatment, products and markets, and recommendations. Samples supplied to in CANMET were processed to produce high–purity sand. Results are included in *CANMET Division Report* MSL 86–50 (IR), 1986 (N.S. –15, Ref. No. 3).
Potential Use	:	Not applicable.

Identification : **N.S. - 15.** (Ref. No. 3)

Report - Title : CANADIAN SILICA RESOURCES: A STUDY OF THE PROCESSING OF SILICA SAMPLES FROM N.S., N.B., MAN.,SASK. AND B.C. FOR GLASS AND FOUNDRY SAND.

- Author(s) : R.K. Collings and P.R.A. Andrews
- No. and Date: CANMET, *Divisional Report* 86-50 (IR), 1986

Nova Scotia Samples

Sample Description : Sand samples from seven locations: Shubenacadie (sub-angular); Nine Mile River and Musquodoboit (sub-angular to sub-rounded); Indian Head, Belmont and Diogenes Brook (sub-rounded); Elmsdale (shape not determined). Head sample analyses varied between 89.7-98.8% SiO_2, 0.29-0.60% Fe_2O_3, 0.35-6.14% Al_2O_3 and 0.04-0.70% TiO_2.

Mineralogy : Impurities included ilmenite, rutile, zircon, feldspar, pyrite, iron-stained quartz.

Objective : Evaluation as glass and foundry sand

Processing : Screening, agglomerate reduction, attrition scrubbing and washing, high-intensity dry magnetic separation. Extensive flotation tests were made on the Shubenacadie samples. The Elmsdale sand, being low-grade, was not processed.

Results : The end products, with the exception of Shubenacadie sand, contained excessive quantities of iron oxide and alumina. The best results obtained with four sands were as follows:

	Product Analyses		
Sample Location	SiO_2	Fe_2O_3	Al_2O_3
Shubenacadie	99.6	0.04	0.10
Nine Mile River	99.1	0.09	0.23
Musquodoboit	99.2	0.09	0.23
Diogenes Brook	99.0	0.08	0.21

More intensive processing, including flotation, could be utilized to further improve these products.

Potential Use : Possibly suitable for manufacturing clear glass, with further beneficiation to reduce iron oxide. Some of the coarser sizes of sand could be utilized for manufacturing silicon carbide.

Prince Edward Island

Identification : **P.E.I. – 1** (Ref. No. 38)

Report – Title : FOUNDRY POTENTIAL OF BEACH SANDS
– Author(s) : A.E. Murton
– No. and Date : CANMET, *Investigation Report* 60–49, 1960.

Sample Description : Beach sands analyzing 95% quartz, 4% feldspar, 1% ferromagnesian minerals.

Objective : To evaluate typical beach sands for foundry moulding purposes.

Processing : Foundry moulding and core testing.

Results : Sands were suitable as iron moulding and core sand, but the relatively high impurities (feldspar and ferromagnesian minerals) caused the sand to sinter at low temperatures, thus making it unsuitable for steel moulding.

Potential Use : Suitable as iron moulding and core sand.

Identification : **P.E.I. – 2** (Ref. No. 39)

Report – Title : INVESTIGATION OF SOURIS SAND
– Author(s) : R.K. Collings
– No. and Date : CANMET, *Investigation Report* 64–54, 1964.

Sample Description : Beach sand, principally iron–stained quartz with small quantities of feldspar, hornblende, clay and mica analyzing 95.71% SiO_2, 0.18% Fe_2O_3; 1.50% Al_2O_3.

Objective : Evaluation as glass sand

Processing : Sizing, magnetic separation, acid leaching, roasting followed by magnetic separation, scrubbing.

Results : Removal of the minus 210 μm fraction followed by magnetic separation and leaching of the plus 210 μm sand reduced the iron content to 0.04% Fe_2O_3.

Potential Use : Probably would be suitable for manufacturing coloured glass but not clear glass.

Identification : **P.E.I. – 3** (Ref. No. 40)

Report – Title : TREATMENT OF SOURIS SAND BY JONES MAGNETIC SEPARATOR
– Author(s) : W.J.D. Stone, Quebec Smelting and Refining
– No. and Date: *Report* (unnumbered), 1965.

Sample Description : A 50 kg beach sand sample, principally quartz with minor ferromagnesian minerals.

Objective : To remove iron–bearing minerals by high–intensity magnetic separation.

Processing : Treatment in the Jones high–intensity wet magnetic separator.

Results : The iron oxide content was reduced to 0.10%; iron oxide content would be further reduced by scrubbing and removal of the minus 150 μm fines prior to magnetic separation.

Potential Use : Possibly suitable as glass sand with further beneficiation to reduce iron oxide levels.

Identification : **P.E.I. – 4** (Ref. No. 41)

Report – Title : COMMERCIAL APPLICATIONS FOR P.E.I. SILICA SAND, 1975
– Author(s) : W.J. Lamond
– No. and Date: *Report* (unnumbered), 1975

Sample Description : A sample of beach and dune sands principally composed of quartz with varying percentages of feldspar.

Objective : To identify potential commercial applications for these sands.

Processing : Magnetic separation.

Results : Sands in the area extending from Souris to East Point were considered suitable for glass sand; grain shape was more rounded in this area than that of sand from other areas.

Potential Use : Suitable for manufacturing clear glass.

Note : Report contains good descriptions of silica uses.

New Brunswick

Identification	:	**N.B. – 1** (Ref. No. 45)
Report – Title	:	BENEFICIATION OF A SAMPLE OF SILICA FROM SUSSEX, NEW BRUNSWICK
– Author(s)	:	P.R.A. Andrews
– No. and Date	:	*Division Report* 86–2 (IR), 1986.
Sample Description	:	Granular with a considerable quantity of sticky 100 mm clay–quartz agglomerates analyzing 95.67% SiO_2, 2.51% Al_2O_3, 0.23% Fe_2O_3, 0.08% TiO_2 and 1.04% LOI. Quartz ranged from 150 mm rounded pebbles to sub–angular minus 105 μm slime. Minor minerals included garnet, ilmenite, goethite, rutile and mica.
Objective	:	Evaluation as a source of glass sand.
Processing	:	Scrubbing, washing, desliming and screening to remove clay; magnetic separation and spiral concentration to remove iron oxide minerals.
Results	:	A product analyzing 99.48% SiO_2, 0.04% Fe_2O_3 and 0.17% Al_2O_3 was obtained. Further scrubbing and washing should reduce the iron oxide and alumina levels to glass–sand specifications.
Potential Use	:	Possibly suitable for manufacturing clear glass.

Identification : **N.B. – 2** (Ref. No. 3)

Report – Title : CANADIAN SILICA RESOURCES: A STUDY OF THE PROCESSING OF SELECTED SILICA SAMPLES FROM N.S., N.B., MAN., SASK. AND B.C. FOR GLASS AND FOUNDRY SAND

– Author(s) : R.K. Collings and P.R.A. Andrews

– No. and Date: CANMET, *Division Report* 86–50 (IR), 1986.

New Brunswick Sample (Sussex)

Sample Description : Granular with a considerable quantity of sticky 100 mm clay–quartz agglomerates analyzing 95.67% SiO_2, 2.51% Al_2O_3, 0.23% Fe_2O_3, 0.08% TiO_2 and 1.04% LOI. Quartz ranged from 150 mm rounded pebbles to sub–angular minus 105 μm slime. Minor minerals included garnet, ilmenite, goethite, rutile and mica.

Objective : To evaluate as glass and foundry sand.

Processing : Head sample was screened at 420 μm to remove coarse lump silica and processing was conducted on the minus 420 μm size fraction. Processing included sizing, attrition scrubbing, washing, magnetic separation and flotation.

Results : Magnetic separation reduced the iron oxide and alumina contents to 0.04% Fe_2O_3 and 0.20% Al_2O_3; flotation further reduced these impurities to 0.03% and 0.07% respectively and increased the silica content to 99.53% SiO_2. Foundry evaluation tests indicated good potential for this sand in foundry moulding although further testing and evaluation is recommended to ensure suitability.

Potential Use : Suitable for manufacturing clear glass and as foundry sand.

Quebec

Identification : **Que. – 1** (Ref. No. 50)

Report – Title : ELIMINATION OF IRON FROM EAST TEMPLETON SAND
– Author(s) : R.K. Carnochan
– No. and Date: CANMET, *Ore Dressing Investigation Report* 284, 1928.

Sample Description : A sample of pyritic sandstone with rounded grains analyzing 0.15 to 0.30% Fe_2O_3.

Objective : Evaluation as glass sand.

Processing : Crushing and screening to recover minus 600 plus 100 μm fraction, washing, roasting, magnetic separation, flotation, tabling.

Results : Flotation was not successful in reducing the iron oxide content; roasting and magnetic separation reduced iron oxides to 0.06%.

Potential Use : Possibly suitable for manufacturing clear glass, after further beneficiation to reduce iron oxide levels.

Identification : **Que. – 2** (Ref. No. 51)

Report – Title : BENEFICIATION OF LAKE TIMISKAMING SAND (GUIGUES TWP)
– Author(s) : R.K. Carnochan
– No. and Date: CANMET, *Ore Dressing Investigation Report* (unnumbered), 1930.

Sample Description : Coarse grained, white and brown sand samples; 97% minus 5 mm.

Objective : Evaluation as glass, foundry and sandblast sand.

Processing : Crushing, washing, screening to recover minus 840 plus 420 μm fraction, tabling.

Results : Washed product analyzed 0.06% Fe_2O_3, 0.04% TiO_2; recovery was 74%. Product from tabling and screening analyzed 0.05% Fe_2O_3, 0.01% TiO_2; recovery was 49%.

Potential Use : White sand of interest as source of glass sand for manufacturing clear glass; both sands suitable for foundry and sandblast applications.

Identification : **Que. – 3** (Ref. No. 52)

Report – Title : EXAMINATION OF BEAUHARNOIS SANDSTONE
– Author(s) : L.H. Cole and R.K. Carnochan
– No. and Date : CANMET, *Ore Dressing Investigation Report* (unnumbered), 1931.

Sample Description : Thirteen samples of sandstone and sand; sandstone composed of well–rounded grains which were iron–stained and bonded with calcite. The natural grain size was 420 to 210 μm and minor minerals included hornblende.

Objective : Evaluation as glass sand.

Processing : Crushing, screening, washing.

Results : Losses due to washing averaged 15%, and the iron oxide content remained high. Acid leaching could be employed to reduce iron oxide content.

Potential Use : Not determined.

Identification : **Que. – 4** (Ref. No. 53)

Report – Title : CRUSHING AND WASHING OF SANDSTONE FROM GATINEAU POINT
– Author(s) : R.K. Carnochan
– No. and Date : CANMET, *Ore Dressing Investigation Report* (unnumbered), 1932.

Sample Description : Two samples of weathered coarse–grained sandstone; first sample was white and analyzed 0.09% Fe_2O_3, the second was gray to brown and analyzed 0.25% Fe_2O_3; no pyrite was reported.

Objective : Evaluation as glass sand.

Processing : Crushing, sizing and washing to minus 1.4 mm plus 150 μm.

Results : The iron oxide content of the white sample was reduced to 0.051 – 0.064% Fe_2O_3, and for the gray–brown sample to 0.11 to 0.14% Fe_2O_3.

Potential Use : Possibly suitable for manufacturing clear glass after further beneficiation to reduce iron oxide levels.

Identification : **Que. – 5** (Ref. No. 54)

Report – Title : TESTING QUARTZ FROM LAROUCHE, CHICOUTIMI AREA
– Author(s) : R.K. Carnochan
– No. and Date : CANMET, *Ore Dressing Investigation Report* (unnumbered), 1932.

Sample Description : A sample of white to rose quartz with some iron staining analyzing 99.12% SiO_2, 0.09% Fe_2O_3.

Objective : Evaluation for use in glass, sandblast applications, ceramics and paint.

Processing : Crushing to minus 840 μm (glass and foundry); sandblast trials; grinding to 100% minus 75 μm (ceramic); grinding to 100% minus 45 μm (paint filler).

Results : Washing and removal of minus 150 μm resulted in a product analyzing 99.74% SiO_2, 0.043% Fe_2O_3, 0.006% TiO_2. The sand was reported as only "fair" for sandblasting and was not suitable for ceramics because of the appearance of large black "iron spots" on firing.

Potential Use : Suitable for manufacturing clear glass. The minus 45 μm product would have application in certain grades of coloured paint.

Identification : **Que. – 6** (Ref. No. 55)

Report – Title : TESTS ON QUARTZ AND CHINA CLAY FROM LAC RÉMI
– Author(s) : R.K. Carnochan
– No. and Date : CANMET, *Ore Dressing Investigation Report* 473, 1933.

Sample Description : Three sample lots of white quartz with associated white China clay analyzing 1.30% Al_2O_3, 0.06% Fe_2O_3, 0.036% TiO_2.

Objective : Evaluation of quartz as source of glass and ceramic sand and evaluation of China clay for ceramics.

Processing : Washing, tabling and sizing.

Results : 48% of sample lot 1, 28% of lot 2, and 71% of lot 3, were recovered.

Potential Use : Each sample was considered suitable for use in manufacturing clear glass ($<0.05\%$ $Fe_2O_3 + TiO_2$). Blasting tests indicated suitability as sandblast sand, and firing tests on minus 75 μm quartz showed acceptability for ceramics. The recovered clay was also suitable for ceramics.

Identification : **Que. - 7** (Ref. No. 56)

Report - Title : SEPARATION OF IRON FROM BEAUHARNOIS SILICA
- Author(s) : R.K. Carnochan
- No. and Date: CANMET, *Ore Dressing Investigation Report* (unnumbered), 1937.

Sample Description : A sample of crushed sandstone, 100% minus 840 μm in size, and analyzing 0.22% Fe_2O_3 with free and attached pyrite in small amounts.

Objective : Evaluation as glass sand.

Processing : Washing, tabling, magnetic separation, roasting, acid leaching.

Results : Reduction of iron oxide content to 0.04% Fe_2O_3.

Potential Use : Suitable for manfuacturing clear glass

Identification : **Que. - 8** (Ref. No. 57)

Report - Title : MILLING OF SANDSTONE FROM GATINEAU POINT
- Author(s) : R.K. Carnochan
- No. and Date: CANMET, *Ore Dressing Investigation Report* (unnumbered), 1937.

Sample Description : White weathered sandstone with no evidence of pyrite and only minor iron-staining, analyzing 0.075% Fe_2O_3.

Objective : Evaluation as source of glass sand.

Processing : Crushing, screening, sizing and washing, tabling; two tests, No. 1 minus 600 plus 150 μm sand, No. 2 minus 1.2 mm, plus 150 μm sand.

Results : Iron oxide content was reduced to 0.05% Fe_2O_3 by crushing and washing, and to 0.04% Fe_2O_3 by crushing, washing, tabling and screening.

Potential Use : Possibly suitable for manufacturing clear glass after further reduction by acid leaching of iron oxide to 0.025% Fe_2O_3.

Identification : **Que. - 9** (Ref. No. 58)

Report - Title : EVALUATION OF SILICA FROM ST. DONAT, QUEBEC
- Author(s) : L.H. Cole and R.K. Carnochan
- No. and Date : CANMET, *Report* (unnumbered), 1939.

Sample Description : A sample of sand analyzing 95.20% SiO_2, 3.39% Al_2O_3, 0.10% Fe_2O_3, 0.15% TiO_2.

Objective : Evaluation as source of glass sand.

Processing : Grinding, screening, washing, magnetic separation, tabling.

Results : Washing, magnetic separation and tabling resulted in a concentrate analyzing 98.96% SiO_2, 0.015% Fe_2O_3, 0.026% TiO_2 with an acceptable recovery .

Potential Use : Suitable for manufacturing clear glass despite relatively high content of TiO_2.

Identification : **Que. - 10** (Ref. No. 59)

Report - Title : EVALUATION OF QUARTZITE FROM STE. JULIENNE
- Author(s) : C.H. Freeman
- No. and Date : CANMET, *Ore Dressing Investigation Report* (unnumbered), 1940.

Sample Description : Two samples
No. 347: 97.32% SiO_2, 1.24% Al_2O_3, 0.18% Fe_2O_3, 0.06% TiO_2;
No. 797: 97.68% SiO_2, 0.67% Al_2O_3, 0.19% Fe_2O_3, 0.06% TiO_2.

Objective : Evaluation for sandblast applications and as source of glass sand.

Processing : Crushing to minus 840 µm followed by air classification, and magnetic separation of plus 150 µm fraction from air classifier; sandblast tests.

Results : Processing did not significantly reduce either the iron oxide or titania to acceptable levels for glass sand; sandblast tests were fair, 1.40 g of steel being removed per 450 g of sand.

Potential Use : Suitable as sandblast sand.

Identification : **Que. - 11** (Ref. No. 60)

Report - Title : EVALUATION OF KAMOURASKA QUARTZITE
- Author(s) : R.L. Bennett
- No. and Date : CANMET, *Ore Dressing Investigation Report* 4154, 1941.

Sample Description : Greyish white, fine-grained quartzite with minor iron staining analyzing 98.34% SiO_2, 0.82% Al_2O_3; 0.095% Fe_2O_3.

Objective : Evaluation as source of glass sand.

Processing : Crushing followed by sizing to minus 840 plus 150 μm; washing, magnetic separation, acid leaching.

Results : Crushing produced large percentage of minus 150 μm fines, and acid leaching reduced iron oxide to 0.028% Fe_2O_3.

Potential Use : Suitable for manufacturing clear glass.

Identification : **Que. - 12** (Ref. No. 61)

Report - Title : MOULDING TESTS ON SAND FROM ST. JÉRÔME
- Author(s) : C.H. Freeman
- No. and Date : CANMET, *Ore Dressing Investigation Report* 4155, 1941.

Sample Description : Not described.

Objective : To determine whether a synthetic mixture of local sands with a bonding bentonite could be substituted for U.S. moulding sand in foundries.

Processing : Foundry moulding tests were conducted on a synthetic mixture of 40% local moulding sand and 60% local beach sand using bentonite as a bonding agent.

Results : Results were only fair since the synthetic mixture had a higher compressive strength but lower permeability when compared with the U.S. sand; better sands for this purpose reportedly were available in Terrebonne county.

Potential Use : Probably not suitable as a foundry sand.

Identification : **Que. – 13** (Ref. No. 62)

Report – Title : GRINDING OF SILICA FROM ST. RÉMI D'AMHERST
– Author(s) : R.L. Bennett
– No. and Date: CANMET *Ore Dressing Investigation Report* 4201, 1942.

Sample Description : Light brown silica sand, minus 200 μm in size and analyzing 97.66% SiO_2, 0.44% Fe_2O_3, 0.88% Al_2O_3 with minor mica, magnetic minerals and iron–stained clay.

Objective : Evaluation as source of glass sand.

Processing : Washing, magnetic separation, grinding.

Results : Ground product (78% minus 45 μm) was faintly tinged yellow.

Potential Use : Suitable for manufacturing coloured glass.

Identification : **Que. – 14** (Ref. No. 63)

Report – Title : EVALUATION OF SILICA SAND FROM VILLE MARIE, QUEBEC
– Author(s) : C.H. Freeman
– No. and Date: CANMET *Ore Dressing Investigation Report* 4301, 1943.

Sample Description : Two samples
No. 1 – light yellow, coarse–grained sand with clay impurities, 99% minus 4.8 mm in size and analyzing 0.23% Fe_2O_3, 3.33% Al_2O_3.
No. 2 – light–coloured, very coarse–grained sand with dark iron minerals, minus 25 mm in size.

Objective : Evaluation as source of glass sand.

Processing : Washing, screening, magnetic separation.

Results : Sample 1 – iron oxide was reduced to 0.09% Fe_2O_3; recovery of minus 840 μm sand was 55%.
Sample 2 – iron oxide was reduced to 0.115% Fe_2O_3 and alumina to 1.45% Al_2O_3 in the minus 1.2 mm size.

Potential Use : Each sand is suitable for manufacturing coloured glass and both probably would be satisfactory as foundry moulding and sandblast sand.

Identification : **Que. – 15** (Ref. No. 64)

Report – Title : BENEFICIATION OF LAKE BASKATONG QUARTZ
– Author(s) : L.H. Cole
– No. and Date: CANMET *Ore Dressing Investigation Report* 2339, 1948.

Sample Description : 120 kg of minus 150 mm quartz analyzing 99.52% SiO_2, 0.026% Fe_2O_3, 0.15% Al_2O_3.

Objective : Evaluation as source of glass sand, potter's flint and silica flour.

Processing : Crushing to minus 840 μm, screening to recover the minus 840 plus 150 μm fraction and washing to remove the minus 150 μm fraction. A portion of minus 840 plus 150 μm sand was ground to minus 100 μm for evaluation as potter's flint.

Results : Results indicate feasibility of using this material for glass sand, for potter's flint and as silica flour. Crushing costs would, however, be high because of the toughness of this silica, which would discourage its use as a source of glass sand.

Potential Use : Suitable for potter's flint and as silica flour.

Identification : **Que. – 16** (Ref. No. 65)

Report – Title : TEST WORK ON EAST TEMPLETON SANDSTONE
– Author(s) : A.R. MacPherson
– No. and Date: CANMET *Ore Dressing Investigation Report* 2517, 1949.

Sample Description : Nine tonnes of sandstone with visible pyrite analyzing 98.59% SiO_2, 0.63% Fe_2O_3, 0.38% Al_2O_3.

Objective : Evaluation as glass sand.

Processing : Autogenous milling, magnetic separation, air classification, screening to minus 840 plus 150 μm, wet tabling, flotation of pyrite, spiral classification to separate pyrite, acid leaching.

Results : Beneficiated, acid–leached product analyzed 99.2% SiO_2, 0.03% Fe_2O_3, 0.02% Al_2O_3.

Potential Use : Suitable for manufacturing clear glass.

Identification : **Que. - 17** (Ref. No. 66)

Report - Title : REMOVAL OF PYRITE FROM EAST TEMPLETON SANDSTONE
- Author(s) : H.L. Beer
- No. and Date: CANMET *Ore Dressing Investigation Report* (unnumbered), 1950.

Sample Description : Sandstone with visible pyrite analyzing 0.23% Fe, 0.19% S.

Objective : Reduction of pyrite.

Processing : Sandstone was reduced to 600 µm and beneficiated by agglomerate tabling and flotation.

Results : Table concentrate analyzed 98.64% SiO_2, 0.16% Fe, 0.09% S, 0.42% Al_2O_3; pyrite was observed in the middling product attached to coarser particles of quartz. A finer grind is required to further liberate the pyrite from the quartz.

Potential Use : Unsuitable for manufacturing clear glass.

Identification : **Que. - 18** (Ref. No. 67)

Report - Title : FLOTATION OF IRON AND ALUMINUM OXIDES FROM ST. CANUT SILICA
- Author(s) : H.L. Beer
- No. and Date: CANMET *Ore Dressing Investigation Report* (unnumbered), 1951.

Sample Description : Three samples of crushed, minus 600 µm sand containing mica and clay as the principal impurities.
1. - Aerofall mill product, 0.046% Fe_2O_3, 0.46% Al_2O_3
2. - Top bench (St. Canut quarry), 0.048% Fe_2O_3, 0.28% Al_2O_3
3. - No. 2 bench (St. Canut quarry), 0.062% Fe_2O_3, 0.38% Al_2O_3

Processing : Flotation, alkali scrubbing, magnetic separation.

Results : Magnetic separation and alkali scrubbing were not as effective as flotation. Flotation was, however, only partially successful in reducing iron oxide content. The best results were obtained with the Aerofall mill product following removal of the plus 600 µm fraction when flotation reduced the iron oxide to 0.023% Fe_2O_3. The iron oxide contents of samples 2 and 3 were reduced to only 0.043% Fe_2O_3.

Potential Use : Sample 1 is suitable for manufacturing clear glass. Samples 2 and 3 would possibly be suitable for manufacturing clear glass with further processing to reduce iron oxide.

Identification : **Que. - 19** (Ref. No. 68)

Report - Title : CONCENTRATION OF GRANITE-PEGMATITE FROM SAGUENAY
- Author(s) : H.L. Beer
- No. and Date: CANMET *Ore Dressing Investigation Report* (unnumbered), 1952.

Sample Description : Granite-pegmatite rock, chiefly composed of quartz with muscovite, biotite and minor feldspar and apatite.

Objective : Recovery of a siliceous product suitable for glass manufacture.

Processing : Crushing followed by screening at 420 μm, magnetic separation to remove muscovite and biotite. Flotation to remove feldspar and mica followed by magnetic separation.

Results : Magnetic separation resulted in a product analyzing 98.56% SiO_2, 0.008% Fe_2O_3, 0.71% Al_2O_3 with a recovery of 51% of the minus 420 μm material.

Potential Use : Suitable for the manufacture of certain types of glass.

Identification : **Que. - 20** (Ref. No. 69)

Report - Title : TESTWORK ON ST. CANUT SANDSTONE.
- Author(s) : R.K. Collings and R.A. Simpson
- No. and Date: CANMET, *Industrial Minerals Report* 180, 1953.

Sample Description : 4.5 t St. Canut sandstone, minus 450 mm in size.

Objective : To evaluate a Marcy Centre Peripheral Discharge rod mill as a secondary crusher for reducing sandstone to its inherent grain size.

Processing : Preliminary reduction to minus 20 mm by jaw crusher, removal of minus 600 μm fines followed by reduction of the plus 600 μm fraction in the CPD rod mill.

Results : The Marcy CPD rod mill satisfactorily reduced the feed material to grain size without excessive production of fines (minus 100 μm).

Potential Use : Not determined.

Identification : **Que. – 21** (Ref. No. 70)

Report – Title : BENEFICIATION OF SAND FROM ST. CANUT
– Author(s) : R.K. Collings
– No. and Date : CANMET, *Industrial Minerals Report* 262, 1954.

Sample Description : 100 kg of iron–stained sand, rounded to angular in grain shape, 94% minus 600 μm in size and analyzing 99.22% SiO_2, 0.07% Fe_2O_3, 0.13% Al_2O_3.

Objective : Evaluation as source of glass sand.

Processing : Screening to remove plus 600 μm compound grains, attrition scrubbing and washing to free and remove clay, dry magnetic separation.

Results : The beneficiated product analyzed 99.44% SiO_2, 0.052% Fe_2O_3, 0.15% Al_2O_3.

Potential Use : Possibly suitable for manufacturing clear glass with further beneficiation, e.g., acid leaching.

Identification : **Que. – 22** (Ref. No. 71)

Report – Title : FOUNDRY POTENTIAL OF ST. CANUT SAND
– Author(s) : A.E. Murton
– No. and Date : CANMET, *Physical Metallurgy Report* 9837, 1954.

Sample Description : Sand product from CANMET study *Industrial Minerals Report* 262, Que. – 21 (Ref. No. 70).

Objective : Evaluation as foundry moulding sand.

Processing : Foundry moulding and core tests.

Results : The sand proved to be satisfactory for use as a moulding or core sand but slightly inferior to the Ottawa, Illinois sand standard. At AFS No. 48 this sand is slightly coarse; however, removal of the coarser sizes would reduce the AFS number.

Potential Use : Suitable as a moulding or core sand.

Identification : **Que. – 23** (Ref. No. 72)

Report – Title : BY–PRODUCT QUARTZITE FINES FOR SILICA–BRICK MANUFACTURE
– Author(s) : S. Matthews
– No. and Date : CANMET, *Industrial Minerals Report* 347, 1955.

Sample Description : 225 kg of minus 20 mm., light–grey quartzite from Melocheville analyzing 96.03% SiO_2, 0.10% Fe_2O_3, 0.59% Al_2O_3.

Objective : Evaluation of quartzite as raw material for silica brick manufacture.

Processing : Crushed to minus 3.4 mm and split into 50 kg lots. Each 50 kg batch was mixed with 1.5% Copacite and 2% CaO, and 12 bricks formed by power pressing. The bricks were fired to 1485°C and cooled over a 7–day period.

Results : The bricks were sound and of good appearance.

Potential Use : Suitable for manufacturing silica brick.

Identification : **Que. – 24** (Ref. No. 73)

Report – Title : INVESTIGATION OF BEAUHARNOIS SANDSTONE
– Author(s) : V.A. Haw
– No. and Date : CANMET, *Industrial Minerals Report* 375, 1955.

Sample Description : 5.5 t of minus 200 mm sandstone submitted by the St. Lawrence Seaway Authority.

Objective : Evaluation as concrete aggregate for use in construction of the St. Lawrence Seaway.

Processing : Primary crushing by jaw, cone and roll crushers with secondary crushing in a centre peripheral discharge rod mill; air classification to remove the minus 150 μm fines.

Results : Each comminution stage produced excessive quantities of minus 150 μm fines.

Potential Use : Unsuitable for use as concrete aggregate.

Identification	:	**Que. – 25** (Ref. No. 74)
Report – Title	:	FOUNDRY EVALUATION OF ST. CANUT SAND
– Author(s)	:	A.E. Murton
– No. and Date	:	CANMET, *Physical Metallurgy Reports* 10356, 10360, 1956.
Sample Description	:	Crushed and scrubbed Potsdam sandstone, grains rounded to sub–angular.
Objective	:	Evaluation as foundry moulding and core sand.
Processing	:	Foundry moulding and core test.
Results	:	Sand is suitable for foundry moulding because of its refractory nature, and round to sub–angular grain shape. It is not suitable, however, as core sand.
Potential Use	:	Suitable as a foundry sand.

Identification : **Que. – 26** (Ref. No. 75)

Report – Title : BENEFICIATION OF ST. CANUT SILICA
– Author(s) : R.K. Collings
– No. and Date : CANMET, *Industrial Minerals Report* 59–22, 1959.

Sample Description : Four samples
A – light gray sandstone analyzing 99.42% SiO_2, 0.05% Fe_2O_3, 0.23% Al_2O_3
B – impure sandstone with calcite and ferromagnesian minerals analyzing 98.78% SiO_2, 0.09% Fe_2O_3, 0.28% Al_2O_3
C – iron–stained sandstone analyzing 99.38% SiO_2, 0.06% Fe_2O_3, 0.25% Al_2O_3
D – impure, calcareous sandstone 82.70% SiO_2, 0.26% Fe_2O_3, 0.21% Al_2O_3

Objective : To remove impurities and upgrade to glass sand.

Processing : Samples were reduced to minus 840 µm by jaw and roll crusher, screened at 420 and 100 µm and treated by magnetic separation. A series of comparative crushing tests was made by pebble milling.

Results : Product analyses after milling, screening at minus 420 plus 100 µm, and magnetic separation were as follows:

A – 0.06% Fe_2O_3, 0.20% Al_2O_3
B – 0.08% " , 0.26% "
C – 0.05% " , 0.23% "
D – 0.13% " , 0.17% "

Very little significant improvement resulted except in sample D; attrition scrubbing followed by washing and acid leaching could be utilized to further reduce the iron oxide and alumina contents of these sands.

Potential Use : Samples A,B and C with further beneficiation could possibly be suitable for manufacturing clear glass.

Identification : **Que. – 27** (Ref. No. 76)

Report – Title : REMOVAL OF IRON FROM ST. CANUT SAND BY CHLORINATION
– Author(s) : R.J.P. Whalley and T.R. Ingraham
– No. and Date: CANMET, *Mineral Dressing Investigation Report* 59–4, 1959.

Sample Description : Sand

Objective : Removal or reduction of iron oxide content by chlorination.

Processing : Reduction roasting and chlorination.

Results : Chlorination successfully reduced the iron oxide content to 0.025% Fe_2O_3 but further reduction was impractical due to the iron oxide being locked within actual quartz grains. A similar study* reported iron levels as low as 0.017% Fe_2O_3 with head samples analyzing 0.064% Fe_2O_3.

Potential Use : Suitable for manufacturing clear glass.

Identification : **Que. – 28** (Ref. No. 77)

Report – Title : REMOVAL OF IMPURITIES FROM ST. CANUT SILICA SAND BY ACID LEACHING
– Author(s) : R.K. Collings
– No. and Date: CANMET, *Industrial Minerals Report* 59–26, 1959.

Sample Description : 50 kg of sand analyzing 0.062% Fe_2O_3, 0.23% Al_2O_3.

Objective : Reduction of iron oxide to glass–grade specification.

Processing : Dry magnetic separation followed by acid leaching using dilute H_2SO_4 with $KMnO_4$ as an oxidizing agent.

Results : Leaching reduced the iron oxide and alumina contents to 0.038% Fe_2O_3 and 0.133% Al_2O_3.

Potential Use : Suitable for manufacturing clear glass.

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* Ontario Research Foundation, Mississauga, Ontario.

Identification : **Que. – 29** (Ref. No. 78)

Report – Title : BENEFICIATION OF SILICA SAND FROM HOLTON
– Author(s) : R.K. Collings
– No. and Date: CANMET, *Investigation Report* 59–34, 1959.

Sample Description : 70 kg of minus 10 mm, fine–grained sandstone analyzing 98.60% SiO_2, 0.27% Fe_2O_3, 0.34% Al_2O_3, 0.41% L.O.I. The grain shape was rounded to sub–angular, and the principal impurities were quartz with minor calcite, dolomite, hornblende, pyrite and iron staining.

Objective : Evaluation as a source of glass and silicon carbide sand.

Processing : Sample was crushed to 840 μm, scrubbed and washed to remove fines, dried and treated by high–intensity magnetic separation.

Results : The non–magnetic fraction analyzed 99.39% SiO_2, 0.06% Fe_2O_3, 0.10% Al_2O_3, 0.18% L.O.I.; the iron oxide specification for glass is 0.025% Fe_2O_3.

Potential Use : Possibly suitable for manufacturing silicon carbide, although a coarser sized sand is normally preferred.

Identification : **Que. – 30** (Ref. No. 79)

Report – Title : POTSDAM SANDSTONE, CORE SAMPLE INVESTIGATION
– Author(s) : R.K. Collings
– No. and Date: CANMET, *Mineral Processing Test Report* 60–51, 1960.

Sample Description : Two samples of Potsdam sandstone drill core from area to the south of Montreal

1. – 55 kg analyzing 0.30% Fe_2O_3, 2.78% Al_2O_3
2. – 60 kg analyzing 0.20% Fe_2O_3, 1.20% Al_2O_3.

Objective : Evaluation as potential source of glass sand.

Processing : Jaw crushing to minus 6 mm, further crushing to grain size by roll crusher, screening to remove minus 840 μm with pebble–mill reduction of oversize, scrubbing and washing to remove fines, magnetic separation.

Results : Analyses of beneficiated products were as follows:

1. – 0.104% Fe_2O_3, 1.67% Al_2O_3
2. – 0.08% Fe_2O_3, 0.49% Al_2O_3

Material represented by these analyses, being high in both iron oxide and alumina, would be unsatisfactory for use as glass sand without additional beneficiation.

Potential Use : These sands might be satisfactory for manufacturing clear glass with additional beneficiation to reduce the iron oxide and alumina levels.

Identification : **Que. - 31** (Ref. No. 80)

Report - Title : BENEFICIATION OF SAND FROM GUIGUES TOWNSHIP
- Author(s) : R.K. Collings
- No. and Date: CANMET, *Mineral Processing Test Report* 60-101, 1960.

Sample Description : 25 kg of loosely consolidated sandstone where quartz grains were sub-angular in shape, and impurities included iron-staining, pyrophyllite and muscovite.

Objective : Evaluation as a potential source of glass-grade sand.

Processing : Reduction to grain size by muller mixer followed by attrition scrubbing and washing to remove slimes. The product was dried and treated by high-intensity magnetic separation.

Results : Analysis of beneficiated product was 98.5% SiO_2, 0.03% Fe_2O_3, 0.50% Al_2O_3; product recovery was 90%. The alumina content is substantially higher than that specified for glass sand; however, with more vigorous scrubbing, washing and flotation, the alumina content would be reduced.

Potential Use : Possibly suitable for manufacturing clear glass.

Identification : **Que. - 32** (Ref. No. 81)

Report - Title : BENEFICIATION OF SAND FROM ST. CANUT
- Author(s) : R.K. Collings
- No. and Date: CANMET *Investigation Report* 60-127, 1960.

Sample Description : Six sand products from a milling facility at St. Canut with rounded to sub-rounded grains analyzing 0.055% Fe_2O_3, 0.20% Al_2O_3. The iron was present as introduced mill-abraded iron, as free and attached grains of pyrite, and as iron staining on the quartz grains.

Objective : Reduction of iron oxide and alumina content to glass-sand specifications.

Processing : Attrition scrubbing and washing to remove impure minus 100 μm fines; magnetic separation; roasting followed by high-intensity magnetic separation.

Results : Attrition scrubbing and washing reduced the alumina content to 0.15% Al_2O_3; attrition scrubbing and magnetic separation reduced the iron oxide to only 0.035% Fe_2O_3. Reduction to the required specification was only achieved by roasting followed by magnetic separation or acid leaching.

Potential Use : Suitable for manufacturing clear glass.

Identification : **Que. – 33** (Ref. No. 82)

Report – Title : BENEFICIATION OF SILICA FROM ST. CANUT
– Author(s) : F.H. Hartman
– No. and Date: CANMET, *Investigation Report* 63–104, 1963.

Sample Description : Minus 600 plus 150 μm sand containing pyrite as a principal impurity and analyzing 0.037% Fe_2O_3.

Objective : To upgrade to glass–sand specifications.

Processing : Superpanning, jigging and tabling.

Results : Tabling reduced the iron oxide content to 0.03% Fe_2O_3.

Potential Use : Suitable for manufacturing clear glass.

Identification : **Que. – 34** (Ref. No. 83)

Report – Title : INVESTIGATION OF SANDSTONE FROM MELOCHEVILLE
– Author(s) : R.K. Collings
– No. and Date: CANMET, *Investigation Report* 64–70, 1964.

Sample Description : 135 kg of fine–grained sandstone with a tough siliceous bond.

Objective : To upgrade to glass–sand specification.

Processing : Sample was reduced to 40 mm by jaw crusher and screened at 4.8 mm and 600 μm; secondary crushing to 600 μm was achieved by autogenous grinding in a pebble mill and by muller mixer. The prepared product was attrition scrubbed and washed to remove minus 100 μm fines and the resulting minus 600 plus 100 μm product was treated by high–intensity magnetic separation.

Results : The final beneficiated product analyzed 0.07% Fe_2O_3 and 0.04% Al_2O_3. The alumina content is well below the glass–sand specification, however, the iron oxide, at 0.07% Fe_2O_3, exceeds the iron oxide specification.

Potential Use : Suitable for manufacturing coloured glass.

Identification	:	**Que. - 35** (Ref. No. 84)
Report - Title	:	REMOVAL OF PYRITE FROM POTSDAM SANDSTONE BY ELECTROSTATIC METHODS
- Author(s)	:	R.K. Collings
- No. and Date	:	CANMET, *Investigation Report* 65-5, 1965.
Sample Description	:	Potsdam sandstone from Melocheville analyzing 0.13% Fe_2O_3.
Objective	:	To reduce iron oxide content (pyrite) to glass-sand specification.
Processing	:	Sandstone was reduced to grain size and screened at 600 and 100 μm. The minus 600 plus 100 μm fraction was treated by electrostatic separation and by high-intensity magnetic separation.
Results	:	Removal of the unattached free grains of pyrite was easily accomplished by the electrostatic separator; however, the small attached grains remained unaffected. Magnetic separation had little apparent effect on the pyrite, and although a 50% reduction of the iron was achieved, the resulting sand at 0.07% Fe_2O_3 was above the glass sand specification.
Potential Use	:	Suitable for manufacturing coloured glass.

Identification : **Que. – 36** (Ref. No. 85)

Report – Title : RECOVERY OF HIGH PURITY SAND FROM STE. CLOTHILDE DE CHATEAUGUAY SANDSTONE

– Author(s) : R.K. Collings

– No. and Date : CANMET, *Investigation Report* 65–82, 1965.

Sample Description : Composite core and diamond drill hole samples of carbonaceous sandstone with free and quartz–attached pyrite and some iron staining.

Composite core samples A and B analyzing 0.06 to 0.07% Fe_2O_3, 0.15 to 0.17% Al_2O_3

D.D.H. No. 6 core samples C and D analyzing 0.21% Fe_2O_3, 0.38 to 0.44% Al_2O_3.

Objective : Beneficiation to glass–grade sand.

Processing : Crushing and sizing to minus 600 plus 100 μm; samples A and B – magnetic separation, electrostatic separation, scrubbing, washing and flotation; samples C and D – leaching, washing, dry magnetic and electrostatic separation.

Results : Pyrite could not be completely removed due to non–liberation from quartz, consequently Fe_2O_3 levels are too high for clear glass manufacture with the possible exception of sample C.

Sample A – 0.046% Fe_2O_3, 0.11% Al_2O_3
" B – 0.060% " , 0.10 "
" C – 0.023% " , 0.008% "
" D – 0.086% " , 0.044% "

Potential Use : Sample C is suitable for manufacturing clear glass. Samples A, B and D could possibly be suitable for manufacturing clear glass with further processing.

Identification	:	**Que. – 37** (Ref. No. 86)
Report – Title	:	BENEFICIATION OF SILICA FROM ST. CANUT
– Author(s)	:	R.A. Wyman
– No. and Date	:	CANMET, *Investigation Report* 66–34, 1966.
Sample Description	:	Cyclone products from the mill at St. Canut, minus 600 plus 150 μm in size analyzing 0.028 to 0.034% Fe_2O_3. The principal impurities included minor agglomerates and oxidized pyrite.
Objective	:	To reduce pyrite and lower iron oxide content to meet glass sand specification.
Processing	:	Tabling.
Results	:	Although some pyrite was removed, complete removal was not possible due to quartz–attached small grains of pyrite that resulted in a middlings product. The iron oxide content of the beneficiated product ranged from 0.021 to 0.033% Fe_2O_3.
Potential Use	:	Suitable for manufacturing clear glass.

Identification	:	**Que. - 38** (Ref. No. 87)
Report - Title	:	BENEFICIATION OF MAGDALEN SAND FOR FOUNDRY, GLASS - MAKING AND BUILDING MATERIALS
- Author(s)	:	G.I. Mathieu
- No. and Date	:	CANMET, *Division Report* 82-5 (IR), 1982.
Sample Description	:	Sand samples from deposits located in off-shore water northeast and southwest of the Magdalen Islands analyzing 88% quartz, 10% feldspar, 2% shell and minor heavy minerals, 0.23% Fe_2O_3 and 2.21% Al_2O_3.
Objective	:	To produce separate quartz and feldspar concentrates, the quartz for use as glass and foundry sand, and the feldspar for use in ceramics.
Processing	:	Scrubbing, washing, flotation, magnetic separation and acid leaching.
Results	:	A glass sand product analyzing 99.6% SiO_2, 0.20% Al_2O_3, 0.025% Fe_2O_3, 0.02% TiO_2, was produced by flotation followed by acid leaching. A foundry sand analyzing 98.0% SiO_2, 0.26% Al_2O_3 was produced by flotation.
Potential Use	:	Suitable for manufacturing clear glass and foundry sand. The feldspar concentrate was considered to be suitable for use in some ceramic applications.

Identification : **Que. – 39** (Ref. No. 2)

Report – Title : CANADIAN SILICA RESOURCES: A STUDY OF THE PROCESSING OF SELECTED QUEBEC SILICA SAMPLES FOR GLASS AND FOUNDRY SAND.

– Author(s) : R.K. Collings and P.R.A. Andrews

– No. and Date : CANMET, *Division Report* 84–79 (IR), 1984.

Sample Description : The samples included both sandstone and quartz/quartzite from various locations. Head analyses analyzed 94.66 to 99.54% SiO_2, 0.038 to 0.230% Fe_2O_3, and 0.16 to 4.15% Al_2O_3. Impurities included pyrite, iron oxides, iron staining on quartz grains, carbonates as calcite and aluminum oxide as clay or feldspar.

Objective : To provide material for evaluation as glass and foundry sand.

Processing : Crushing to 600 µm, mulling, scrubbing, washing, flotation and magnetic separation. Beneficiated products were evaluated for use as foundry sand.

Results : Flotation produced concentrates analyzing 99.08 to 99.80% SiO_2, 0.014 to 0.048% Fe_2O_3, and 0.06 to 0.49% Al_2O_3. Silica from Ste. Clothilde, Petit Lac Malbaie, St. Canut, (2 deposits); and Val Brillant, have potential as source material for glass sand. Foundry tests showed that silica from Ste. Clothilde, St. Canut and Val Brillant has potential as foundry sand.

Potential Use : Specific samples are suitable for manufacturing clear glass and as foundry sand.

Identification : **Que. - 40** (Ref. No. 88)

Report - Title : BENEFICIATION OF POTSDAM SANDSTONE
- Author(s) : P.A. Chubb, Canadian Silica Corp. Toronto, Ont.
- No. and Date: *Report* (unnumbered), 1958/59.

Sample Description : Various samples of Potsdam sandstone from the St. Canut area.

Objective : Evaluation as source of glass sand.

Processing : Acid leaching, chlorination, scrubbing, sintering followed by acid leaching and sodium hydroxide leaching.

Results : Various reductions of iron oxide and alumina were reported as follows:

- H_2SO_4 + HCl – 0.028% Fe_2O_3, 0.12% Al_2O_3
- HF – 0.020% Fe_2O_3, 0.03% Al_2O_3
- Chlorination – 0.018% Fe_2O_3, 0.12% Al_2O_3
- Scrubbing – 0.038% Fe_2O_3, 0.075% Al_2O_3
- Scrubbing, sintering* and acid washing – 0.02% Fe_2O_3, – –
- NaOH leach – 0.027% Fe_2O_3, 0.06% Al_2O_3

Potential Use : Suitable for manufacturing clear glass.

Identification : **Que. - 41** (Ref. No. 89)

Report - Title : ECONOMIC FEASIBILITY REPORT, ST. URBAIN SANDSTONE
- Author(s) : J.G. Copeland, Leeds Metals Co. Ltd., Montreal
- No. and Date: *Report* (unnumbered), 1966.

Sample Description : 50 t of quartz with iron oxides, alumina and magnesia as impurities.

Objective : Evaluation as a source of glass-grade sand.

Processing : Autogenous grinding with secondary grinding of the plus 840 µm oversize by ball mill; wet classification of the minus 420 plus 100 µm sand by hydrosizer; wet and dry magnetic separation.

Results : Beneficiated product analyzed 99.34% SiO_2, 0.027% Fe_2O_3, 0.64% Al_2O_3; the iron oxide content at 0.027% Fe_2O_3 satisfies glass-grade specifications, but the alumina, at 0.64% Al_2O_3, exceeds the alumina specification.

Potential Use : Possibly suitable for manufacturing clear glass with further processing to reduce alumina using vigorous attrition scrubbing.

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* Sintering is necessary to oxidize pyrite before removal by acid leaching.

Ontario

Identification : **Ont. – 1** (Ref. No. 98)

Report – Title : TESTING OF QUARTZ AND CLAY FROM SMOKY FALLS
– Author(s) : R.K. Carnochan
– No. and Date : CANMET *Ore Dressing Investigation Report* (unnumbered), 1935.

Sample Description : A sample of minus 15 mm angular white quartz with clay.

Objective : Glass sands and sandblast applications.

Processing : Washing to separate clay from quartz, sizing at minus 850 plus 250 µm, tabling and magnetic separation, sandblast trials.

Results : Clay was easily removed from the quartz by washing; however, further beneficiation by either tabling or tabling and magnetic separation was necessary to produce sand with glass–grade specification. In sandblast tests, 4.45 g of steel were cut per kg of sand consumed.

Potential Use : Suitable for manufacturing clear glass and sandblast sand.

Identification : **Ont. – 2** (Ref. No. 99)

Report – Title : BENEFICIATION OF NELLES CORNERS SANDSTONE
– Author(s) : C.H. Freeman
– No. and Date : CANMET *Ore Dressing Investigation Report* (unnumbered), 1938.

Sample Description : A sample of rust coloured sandstone 6.4 to 150 mm in size analyzing 0.27% Fe_2O_3.

Objective : Recovery of glass–grade sand.

Processing : Grinding to 90% minus 600 µm, flotation, washing, tabling, magnetic separation, acid leaching.

Results : Flotation was not as successful in upgrading the sample as in a companion study by American Cyanamid Ltd. (Ont.–36, Ref. No. 132). Acid leaching of the product from the log washer reduced the iron oxide content to 0.04% Fe_2O_3, the lowest value achieved in this study.

Potential Use : Possibly suitable for manufacturing clear glass.

Identification : **Ont. – 3** (Ref. No. 100)

Report – Title : EVALUATION OF SANDSTONE FROM FRONTENAC COUNTY
– Author(s) : C.H. Freeman and L.H. Cole
– No. and Date : CANMET *Ore Dressing Investigation Report* (unnumbered), 1940.

Sample Description : Five samples composed of pieces ranging from 75 to 150 mm in size analyzing 97.60% SiO_2, 0.92% Al_2O_3, 0.103% Fe_2O_3, 0.06% TiO_2.

Objective : Recovery of glass–grade sand.

Processing : Crushing, screening to minus 850 plus 150 μm, washing, magnetic separation.

Results : A beneficiated sand with a recovery of 80% and analyzing 98.10% SiO_2, 0.85% Al_2O_3, 0.046% Fe_2O_3, 0.035% TiO_2 was obtained.

Potential Use : Possibly suitable for clear glass manufacture with further beneficiation using attrition scrubbing to reduce impurity levels.

Identification : **Ont. – 4** (Ref. No. 101, Part 1)

Report – Title : REPORT ON SANDSTONE FROM JOYCEVILLE
– Author(s) : R.L. Bennett
– No. and Date : CANMET *Ore Dressing Investigation Report* 4156 (Part 1) 1941.

Sample Description : A sample of light grey, friable sandstone with black carbonaceous impurities.

Sample 1. – 0.07% Fe_2O_3, 0.03% TiO_2
Sample 2. – 0.17% Fe_2O_3, 0.02% TiO_2

Objective : Recovery of glass–grade and foundry sand.

Processing : Washing and magnetic separation.

Results : The product recovery for each sample averaged 87% and analyses of beneficiated sands from each sample were as follows:

Sample 1. – 99.04% SiO_2, 0.03% Fe_2O_3, 0.02% TiO_2.
Sample 2. – 98.80% SiO_2, 0.10% Fe_2O_3, 0.02% TiO_2

Potential Use : Each sample was suitable as foundry sand and, with further beneficiation including attrition scrubbing, would probably be suitable for manufacturing clear glass.

Identification : **Ont. – 4** (Ref. No. 101, Part 2)

Report – Title : REPORT ON SANDSTONE FROM JOYCEVILLE
– Author(s) : R.L. Bennett
– No. and Date: CANMET *Ore Dressing Investigation Report* 4156 (Part 2) 1941.

Sample Description : A sample of light grey, friable sandstone analyzing 0.24% Fe_2O_3, 0.10% TiO_2.

Objective : Recovery of glass–grade sand.

Processing : Crushing to 850 μm, washing to remove minus 150 μm fines, magnetic separation and acid leaching.

Results : Leaching resulted in a product analyzing 98.68% SiO_2, 0.022% Fe_2O_3, 0.025% TiO_2.

Potential Use : Suitable for manufacturing clear glass.

Identification : **Ont. – 5** (Ref. No. 102)

Report – Title : TESTING OF QUARTZ FROM VERONA
– Author(s) : C.H. Freeman
– No. and Date: CANMET *Ore Dressing Investigation Report* (unnumbered), 1941.

Sample Description : Angular quartz sand with hornblende, biotite and magnetite impurities, 99.5% minus 850 μm in size.

Objective : Recovery of glass–grade sand.

Processing : Screening to remove minus 150 μm fines, tabling, magnetic separation.

Results : Magnetic separation resulted in a product analyzing 98.99% SiO_2 and 0.016% Fe_2O_3.

Potential Use : Suitable for manufacturing clear glass.

Identification : **Ont. – 6** (Ref. No. 103)

Report – Title : BENEFICIATION OF SAND FROM GARSON
– Author(s) : W. Hutchings
– No. and Date : CANMET *Ore Dressing Investigation Report* 4304, 1943.

Sample Description : A sand sample with angular grain shape, 97.5% minus 300 μm in size analyzing 76.8% SiO_2, 10.1% Al_2O_3, 2.12% Fe_2O_3, 3.63% CaO, 1.40% MgO. Impurities include feldspar, magnetite, and hornblende.

Objective : Evaluation as flux for nickel smelting (95% SiO_2).

Processing : Flotation, magnetic separation and dry sizing to remove minus 75 μm.

Results : The beneficiation methods were unsuccessful in upgrading this material to 95% SiO_2; magnetic separation and flotation produced a concentrate analyzing 82.7% SiO_2, with a recovery of 58.6%.

Potential Use : Too low grade for most uses.

Identification : **Ont. – 7** (Ref. No. 104)

Report – Title : FLOTATION CONCENTRATION OF MANITOULIN ISLAND QUARTZITE
– Author(s) : H.L. Beer
– No. and Date : CANMET *Ore Dressing Investigation Report* 2401, 1948.

Sample Description : Gray–white angular quartzite with some iron–staining containing minor feldspar, magnetite and titanium minerals, 100% minus 850 μm in size angular grain shape; 98.47% SiO_2, 0.70% Al_2O_3, 0.253% Fe_2O_3.

Objective : Recovery of glass–grade silica.

Processing : Screening to remove minus 150 μm, flotation.

Results : The flotation concentrate analyzed 99.29% SiO_2, 0.49% Al_2O_3, 0.06% Fe_2O_3 with a recovery of 96%.

Potential Use : Possibly suitable for manufacturing clear glass but further beneficiation with acid leaching would be required to reduce the iron and alumina.

Identification : **Ont. – 8** (Ref. No. 105)

Report – Title : TEST WORK ON MANITOULIN ISLAND QUARTZITE
– Author(s) : H.L. Beer
– No. and Date: CANMET *Ore Dressing Investigation Report* 2445, 1948.

Sample Description : Quartzite, crushed and sized to minus 25 plus 6.4 mm with minor mica, magnetite and hornblende analyzing 98.42% SiO_2, 0.92% Al_2O_3, 0.24% Fe_2O_3.

Objective : Recovery of sandblast sand, sand for silica–brick manufacture, for moulding and core sand, and silica flour (minus 75 μm).

Processing : Autogenous grinding, screening, magnetic separation, washing.

Results : Screening and magnetic separation resulted in a concentrate analyzing 99.08% SiO_2, 0.53% Al_2O_3, 0.051% Fe_2O_3; additional washing did not substantially improve these analyses.

Potential Use : Sand is suitable as blasting sand, for silica brick manufacture and for the production of silica flour. It was considered unsuitable for core and moulding sand because of its sharply angular grain shape.

Identification : **Ont. – 9** (Ref. No. 106)

Report – Title : EVALUATION OF MANITOULIN ISLAND QUARTZITE
– Author(s) : A.R. MacPherson
– No. and Date: CANMET *Ore Dressing Investigation Report* (unnumbered), 1948.

Sample Description : 12 t of minus 25 plus 6.4 mm quartzite with minor mica, magnetite and hornblende analyzing 98.42% SiO_2, 0.92% Al_2O_3, 0.24% Fe_2O_3.

Objective : Recovery of glass–grade sand.

Processing : Autogenous milling to 1.7 mm, screening at 850 and 150 μm, magnetic separation, washing and spiral classification, drying.
– minus 850 plus 150 μm evaluated as moulding sand
– minus 1.7 mm plus 850 μm evaluated as sandblast sand.

Results : Resulting beneficiated sand analyzed 99.18% SiO_2, 0.49% Al_2O_3, 0.051% Fe_2O_3. The minus 850, plus 150 μm mesh sand is quite high in iron oxide and alumina.

Potential Use : Possibly suitable for manufacturing clear glass with further vigorous attrition scrubbing to reduce iron oxide and alumina. The sharply angular grain shape would discourage use as foundry moulding sand; the coarser, plus 850 μm sand is suitable for sandblast applications and for the manufacture of silica brick.

Identification : **Ont. - 10** (Ref. No. 107)

Report -Title : SILICA BRICK FROM MANITOULIN ISLAND QUARTZITE
-Author(s) : S. Matthews
-No. and Date: CANMET, *Ceramic Report* C2677, 1950.

Sample Description : 250 kg of minus 25 mm quartzite analyzing 97.58% SiO_2, 0.08% Al_2O_3, 0.75% Fe_2O_3; principally quartzite with minor muscovite, sphene, apatite and rutile.

Objective : Evaluation for silica-brick manufacture.

Processing : Crushed, sized and formed into brick.

Results : This quartzite was suitable for the production of silica brick by the power-pressing method of forming, but brick prepared by the slop-mould method was unsatisfactory.

Potential Use : Suitable for manufacturing silica brick using the power-press method.

Identification : **Ont. - 11** (Ref. No. 108)

Report -Title : TESTING OF KILLARNEY QUARTZITE FOR SILICA BRICK
-Author(s) : S. Matthews
-No. and Date: CANMET, *Ceramic Report* C2678, 1950.

Sample Description : 250 kg of quartzite analyzing 98.26% SiO_2, 0.72% Al_2O_3, 0.51% Fe_2O_3; principal but minor impurities include mica, rutile, sphene and iron-oxide staining.

Objective : Evaluation for silica-brick manufacture.

Processing : Crushing, sizing, forming into brick shape.

Results : This quartzite appeared suitable for the production of silica brick by the power-press method.

Potential Use : Suitable for manufacturing silica brick using the power-press method.

Identification : **Ont. – 12** (Ref. No. 109)

Report – Title : EVALUATION OF KINGSTON AREA SILICA AS FOUNDRY SAND
– Author(s) : A.E. Murton
– No. and Date : CANMET, *Physical Metallurgy Report* 2667, 1950.

Sample Description : Three sand samples, AFS #40, #55 and #70.

Objective : Evaluation as foundry core and moulding sand.

Processing : Foundry core and moulding tests.

Results : Results indicated that the samples were sufficiently refractory for use as foundry sand. The grain shape, however, was sub–rounded to angular which indicated unsuitability as core sand, although they would be satisfactory as moulding sand.

Potential Use : Suitable as foundry sand and moulding sand.

Identification : **Ont. – 13** (Ref. No. 110)

Report – Title : FLOTATION OF ALUMINA, FROM BELLS CORNERS SILICA
– Author(s) : H.L. Beer
– No. and Date : CANMET *Ore Dressing Investigation Report* (unnumbered), 1950.

Sample Description : A sample of crushed, minus 600 plus 100 μm sand analyzing 98.0% SiO_2, 1.00% Al_2O_3, 0.12% Fe_2O_3.

Objective : To separate and reduce alumina by flotation to recover a glass–sand concentrate.

Processing : Flotation

Results : 72.4% of the alumina was removed, but the final concentrate contained excessive amounts of both iron oxide and alumina; 99.6% SiO_2, 0.30% Al_2O_3, 0.08% Fe_2O_3; recovery 87.6%.

Potential Use : Suitable for manufacturing coloured glass.

Identification : **Ont. – 14** (Ref. No. 111)

Report – Title : FLOTATION OF KINGSTON AREA SILICA SAND
– Author(s) : H.L. Beer
– No. and Date: CANMET *Ore Dressing Investigation Report* (unnumbered), 1951.

Sample Description : A sample of Potsdam sandstone 97% minus 600 μm in size.

Objective : Recovery of glass–grade sand.

Processing : Flotation, roasting, leaching, agglomeration and tabling.

Results : None of the beneficiation methods produced a sand meeting glass–sand specifications.

Potential Use : Unsuitable for manufacturing glass.

Identification : **Ont. – 15** (Ref. No. 112)

Report – Title : REPORT ON BELLS CORNERS SANDSTONE FOR PRODUCTION OF GLASS SAND
– Author(s) : A.R. MacPherson
– No. and Date: CANMET *Ore Dressing Investigation Report* (unnumbered), 1951.

Sample Description : 100 t of sandstone from a shaft at Bells Corners containing minor pyrite, marcasite, clay silt and analyzing 97.65% SiO_2, 0.74% Al_2O_3, 0.195% Fe_2O_3.

Objective : Recovery of glass–grade sand.

Processing : Sample was crushed by autogenous grinding in an Aerofall mill, screened at 700 μm, and passed through a Gayco air separator to remove minus 100 μm. The minus 700 plus 100 μm ore was passed through an Exolon dry magnetic separator, and the non–magnetic product analyzed 0.062% Fe_2O_3. Dry roasting followed by magnetic separation further reduced iron oxide to 0.036% Fe_2O_3. Electrostatic separation and attrition scrubbing were investigated as methods for reducing pyrite and iron staining.

Results : Final product analyzed 0.036% Fe_2O_3.

Potential Use : Suitable as a source material for manufacturing clear glass.

Identification : **Ont. - 16** (Ref. No. 113)

Report - Title : PROCESSING OF SANDSTONE FROM KINGSTON SILICA MINES
- Author(s) : A.R. MacPherson
- No. and Date: CANMET *Ore Dressing Investigation Report* (unnumbered), 1951.

Sample Description : Sandstone from the Paddle property with minor amounts of clay and carbonaceous material analyzing 95.77% SiO_2, 0.49% Fe_2O_3, 1.58% Al_2O_3.

Objective : Recovery of sand for glass, foundry and artificial abrasives.

Processing : Aerofall milling with fines removal, washing to remove slimes, roasting at 527°C to remove carbonaceous material and to render the iron more amenable to acid leaching, acid leaching of roasted sand at 88°C, flotation to remove alumina.

Results : The acid-leached product analyzed 99.43% SiO_2, 0.02% Fe_2O_3, 0.25% Al_2O_3; best results were obtained by roasting prior to leaching.

Potential Use : Suitable as a source of sand for clear glass, foundry and artificial abrasives manufacture.

Identification : **Ont. - 17** (Ref. No. 114)

Report - Title : RECOVERY OF GLASS-GRADE SAND FROM DUNE SANDS
- Author(s) : R.K. Collings
- No. and Date: CANMET, *Industrial Minerals Report* 158, 1953.

Sample Description : 10 kg of minus 600 μm dune sand containing 45% quartz, 15% feldspar, 20% ferromagnesian minerals, 10% carbonaceous material and minor muscovite.

Objective : Recovery of glass-grade sand.

Processing : Screening to remove minus 100 μm fines, magnetic separation, tabling, flotation to remove feldspar.

Results : The resulting product at 75 to 80% SiO_2 was too impure to warrant use of this particular dune sand as a source of glass-grade sand.

Potential Use : Unsuitable for manufacturing clear glass.

Identification : **Ont. – 18** (Ref. No. 115)

Report – Title : BENEFICIATION OF SAND FROM KINGSTON SILICA MINES
– Author(s) : R.K. Collings
– No. and Date : CANMET, *Industrial Minerals Report* 198, 1953.

Sample Description : Sandstone from the Paddle property near Gananoque analyzing 0.51% Fe_2O_3, 1.42% Al_2O_3.

Objective : Recovery of glass–grade sand.

Processing : Crushing to 20 mm, grinding in a Marcy centre peripheral discharge rod mill, screening at 850 μm, attrition scrubbing and washing to remove 100 μm slimes, dry magnetic separation.

Results : Product analyzed 0.07% Fe_2O_3 and 0.21% Al_2O_3.

Potential Use : With further beneficiation, possibly suitable for manufacturing clear glass.

Identification : **Ont. – 19** (Ref. No. 116)

Report – Title : KILLARNEY BY–PRODUCT QUARTZITE FOR SILICA BRICK
– Author(s) : S. Matthews
– No. and Date : CANMET, *Industrial Minerals Report* 347, 1955.

Sample Description : 250 kg of minus 20 mm, light gray quartzite from Killarney with minor mica and ferromagnesian minerals analyzing 95.13% SiO_2, 1.46% Al_2O_3, 0.22% Fe_2O_3.

Objective : Evaluation as source material for silica–brick production.

Processing : Crushed to 3.4 mm, 50 kg batches mixed with 1.5% Copacite and 2% CaO. Twelve bricks were formed from each batch by power pressing; bricks were oven–fired at 1485°C and cooled over a 7–day period.

Results : The fired bricks, which were marred by fine surface checks, showed abnormally high expansion on firing and were reported to be lacking in refractoriness.

Potential Use : Unsuitable for manufacturing silica brick.

Identification : **Ont. - 20** (Ref. No. 117)

Report - Title : BENEFICIATION OF SAND FOR CANADIAN SILICA CORP. LTD.
- Author(s) : R.K. Collings
- No. and Date : CANMET, *Industrial Minerals Report* 364, 1955.

Sample Description : Two non-magnetic fraction samples of minus 600 μm sand, rounded to sub-angular grains many of which were iron-stained; minor pyrite.
No. 1 - 25 kg analyzing 99.32% SiO_2, 0.042% Fe_2O_3, 0.218% Al_2O_3
No. 2 - 15 kg analyzing 99.33% SiO_2, 0.045% Fe_2O_3, 0.215% Al_2O_3

Objective : Beneficiation to reduce iron oxide and alumina to glass-sand specifications.

Processing : Scrubbing and washing to reduce high-alumina fines and acid leaching to reduce iron oxides.

Results : Scrubbed and leached products analyzed as follows:

No. 1 - 0.027% Fe_2O_3, 0.085% Al_2O_3
No. 2 - 0.026% Fe_2O_3, 0.115% Al_2O_3

Potential Use : Suitable for manufacturing clear glass.

Identification : **Ont. – 21** (Ref. No. 118)

Report – Title : INVESTIGATION OF SYLVANIA SANDSTONE FROM OJIBWAY
– Author(s) : R.K. Collings
– No. and Date : CANMET, *Industrial Minerals Report* 395, 1956.

Sample Description : Three sandstone sample lots ranging from 150 mm down to sand size with sand grains well rounded.
No. 1 – 250 kg, upper sandstone bed, dolomite–bonded sandstone with minor kaolin and shale analyzing 93.6% SiO_2, 0.025% Fe_2O_3, 0.058% Al_2O_3, 1.72% CaO, 1.08% MgO
No. 2 – similar to Lot 1 analyzing 97.33% SiO_2, 0.015% Fe_2O_3, 0.035% Al_2O_3, 0.75% CaO, 0.40% MgO
No. 3 – 50 kg, impure lower sandstone bed with dolomite, minor kaolin, shale and gypsum.

Objective : Recovery of glass–grade sand.

Processing : Lot 1 – crushing to 3.4 mm, scrubbing and washing to remove fines, screening at 600 μm.
Lot 2 – wet screening at 600 μm; minus 600 μm scrubbed and washed to remove fines; plus 600 μm crushed, scrubbed and washed to remove fines. The products were calcined to reduce dolomite and were screened at 600 μm; minus 600 μm was scrubbed, washed and acid leached.
Lot 3 – considered too impure for further processing.

Results : The iron oxide content of the head samples, at 0.015 to 0.025% Fe_2O_3, met glass sand specifications, and acid leaching reduced the dolomite content.

Potential Use : Suitable for manufacturing clear glass.

Identification : **Ont. – 22** (Ref. No. 119)

Report – Title : FOUNDRY POTENTIAL OF SAND FROM JOYCEVILLE
– Author(s) : A.E. Murton
– No. and Date : CANMET, *Physical Metallurgy Report* 58–61. 1958.

Sample Description : Potsdam sandstone drill core samples containing minor clay, calcite and iron oxide with rounded to sub–angular quartz grains.

Objective : Evaluation as a potential source of foundry sand.

Processing : Reduction to grain size followed by scrubbing and washing to remove minus 100 μm fines; foundry moulding and casting tests.

Results : Moulding and casting test results indicated suitability of this sand for steel–foundry use.

Potential Use : Suitable as foundry sand.

Identification : **Ont. – 23** (Ref. No. 120)

Report – Title : STEEL FOUNDRY POTENTIAL OF PITTSBURGH TOWNSHIP SILICA
– Author(s) : A.E. Murton
– No. and Date : CANMET, *Investigation Report* 58–120, 1958.

Sample Description : A 300 kg Potsdam sandstone sample submitted by St. Lawrence Industrial Silica; pre–treated by Aerofall mill reduction to grain size with air classification and washing.

Objective : Evaluation as steel foundry sand.

Processing : Steel foundry moulding tests (see sample description).

Results : Results indicated suitability as foundry–moulding sand, but angularity of grains would discourage use as core sand.

Potential Use : Suitable as foundry sand.

Identification : **Ont. – 24** (Ref. No. 121)

Report – Title : SUMMARY OF LABORATORY STUDIES ON THE PADDLE SANDSTONE DEPOSIT
– Author(s) : H.M. Woodroffe
– No. and Date : CANMET *Ore Dressing Investigation Report* (unnumbered), 1959.

Sample description : Potsdam sandstone, deposit near Gananoque.

Objective : Recovery of glass–grade sand.

Processing : Roasting, leaching, magnetic separation, scrubbing and washing.

Results : The best results were obtained in a pilot–plant run in 1952 (A.R. MacPherson) which incorporated leaching and magnetic separation. A typical product analyzed 99.68% SiO_2, 0.025% Fe_2O_3, 0.18% Al_2O_3, 0.026% TiO_2.

Potential Use : Suitable for manufacturing clear glass.

Identification : **Ont. – 25** (Ref. No. 122)

Report – Title : BENEFICIATION OF BELLEVILLE SAND
– Author(s) : R.A. Wyman
– No. and Date : CANMET, *Investigation Report* 59–57.

Sample Description : Unconsolidated sand containing magnetite (3.75% Fe_2O_3) with accessory minerals including hornblende, pyroxene, garnet, sphene, mica and topaz.

Objective : To reduce iron oxide content to permit use of sand in portland cement manufacture.

Processing : Treatment by Humphrey's spiral and Holman shaking table.

Results : Spiral concentrate recovery was 84% with an iron oxide content of 1.66% Fe_2O_3; recovery from shaking table was also 84% but the iron oxide content was lower at 1.08% Fe_2O_3. Iron oxide content was too high for glass–sand manufacture.

Potential Use : Possibly suitable for manufacturing coloured glass with further beneficiation by magnetic separation.

Identification : **Ont. – 26** (Ref. No. 123)

Report – Title : FOUNDRY POTENTIAL OF POTSDAM SANDSTONE
– Author(s) : A.E. Murton
– No. and Date: CANMET, *Investigation Report* 60–49, 1960.

Sample Description : Nine samples of crushed sandstone from two separate deposits containing minor pyrite.

Objective : Evaluation as foundry moulding and core sand.

Processing : Samples were washed, fines removed and samples prepared and tested as moulding and core sands.

Results : The sand samples contained both compound grains and fractured grains, the fractured grains being sub–angular in shape and brittle, which caused the sands to be generally inferior to Ottawa sand for moulding and core–making. A superior sand undoubtedly could be produced by using other types of equipment for reducing the sandstone to grain size.

Potential Use : Unsuitable as foundry sand or core sand.

Identification : **Ont. – 27** (Ref. No. 124)

Report – Title : INVESTIGATION OF POTSDAM SANDSTONE FROM LEEDS COUNTY
– Author(s) : R.K. Collings
– No. and Date: CANMET, *Investigation Report* 60–17, 1960.

Sample description : Potsdam sandstone analyzing 0.30% Fe_2O_3, 0.58% Al_2O_3.

Objective : Evaluation as potential source of glass–grade silica.

Processing : Reduction to grain size followed by attrition scrubbing and washing, magnetic separation, roasting followed by acid leaching and magnetic separation.

Results : The alumina was readily reduced to 0.20% by attrition scrubbing followed by washing. Reduction of the iron oxide, which was mostly present as pyrite, was difficult. The best value obtained, 0.03% Fe_2O_3, was achieved by roasting to convert the iron sulphide to iron oxide, followed by high intensity magnetic separation. Recovery of beneficiated sand was 80 – 85%.

Potential Use : Suitable for manufacturing clear glass.

Identification : **Ont. – 28** (Ref. No. 125)

Report – Title : FOUNDRY POTENTIAL OF PENETANGUISHENE SAND
– Author(s) : A.E. Murton
– No. and Date: CANMET, *Investigation Report* 60–46, 1960.

Sample description : Unconsolidated sand containing 60% quartz, 30% feldspar and 10% ferromagnesian minerals.

Objective : Evaluation as potential source of foundry sand.

Processing : Magnetic separation to remove ferromagnesian minerals.

Results : Sand was not sufficiently refractory for use as foundry–moulding sand, although it would be suitable as core sand.

Potential Use : Possibly suitable as core sand.

Identification : **Ont. – 29** (Ref. No. 126)

Report – Title : INVESTIGATION OF POTSDAM SANDSTONE CORE SAMPLES FROM ONTARIO AND QUEBEC
– Author(s) : R.K. Collings
– No. and Date: CANMET, *Mineral Processing Test Report* 60–51, 1960.

Sample description : A 40 kg sample of diamond drill core from the Perth area submitted by Canadian Silica Corp. analyzing 0.187% Fe_2O_3, 1.14% Al_2O_3.

Objective : Recovery of glass–grade sand.

Processing : Crushing to minus 3.4 mm followed by grinding in a muller mixer, scrubbing and washing to remove fines, magnetic separation.

Results : The beneficiated product analyzed 0.05% Fe_2O_3, 0.138% Al_2O_3, indicated unsuitability as glass sand without further beneficiation.

Potential Use : Possibly suitable for manufacturing coloured glass with further processing.

Identification : **Ont. – 30** (Ref. No. 127)

Report – Title : PROCESSING OF QUARTZITE FROM SHEGUIANDAH
– Author(s) : R.K. Collings
– No. and Date: CANMET, *Mineral Processing Test Report* 60–56, 1960.

Sample Description : Crushed, light grey quartzite submitted by Canadian Silica Corporation Ltd.

Objective : Recovery of glass–grade sand.

Processing : Sample was screened at minus 850 plus 150 μm, scrubbed, washed to remove fines and treated by magnetic separation.

Results : The resulting product analyzed 98.57% SiO_2, 0.031% Fe_2O_3, 0.48% Al_2O_3.

Potential Use : Possibly suitable for manufacturing clear glass with further processing to reduce alumina.

Identification : **Ont. – 31** (Ref. No. 128)

Report – Title : INVESTIGATION OF LAKE TEMISKAMING AREA SANDSTONE
– Author(s) : R.K. Collings
– No. and Date: CANMET, *Investigation Report* 61–143, 1961.

Sample description : A 100 kg sample of clay–bonded, minus 50 mm, friable sandstone with grains rounded to sub–angular containing kaolin with minor iron–staining.

Objective : Recovery of glass–grade sand.

Processing : Reduction by muller–mixer, attrition scrubbing and washing to remove minus 100 μm fines, acid leaching, dry magnetic separation.

Results : Resulting product analyzed 99.35% SiO_2, 0.013% Fe_2O_3, 0.36% Al_2O_3, indicated high alumina. The alumina was reduced to 0.26% Al_2O_3 by scrubbing with NaOH.

Potential Use : Possibly suitable for manufacturing clear glass with further beneficiation to reduce alumina.

Identification : **Ont. - 32** (Ref. No. 129)

Report - Title : INVESTIGATION OF SAND FROM THE MISSINAIBI RIVER AREA
- Author(s) : R.K. Collings
- No. and Date: CANMET, *Investigation Report* 63-83, 1963.

Sample Description : Sand samples with variable composition, clay was present in each sample, with iron staining of the quartz grains and minor mica.

Objective : Evaluation as a potential source of glass-grade sand.

Processing : Scrubbing and washing to remove clay, air tabling of the dried product to remove mica.

Results : Most of the processed samples analyzed 0.04% Fe_2O_3 or less, and about two-thirds of the samples analyzed less than 0.025% Fe_2O_3. The alumina, however, generally exceeded 0.2% Al_2O_3, indicating potential as source material for the recovery of glass-grade sand.

Potential Use : Suitable for manufacturing clear glass with further beneficiation to reduce alumina.

Identification : **Ont. - 33** (Ref. No. 130)

Report - Title : BENEFICIATION OF SAND FROM MATTAGAMI RIVER, KIPLING TOWNSHIP
- Author(s) : R.K. Collings
- No. and Date: CANMET *Investigation Report* (unnumbered), 1963.

Sample Description : Sample was principally composed of sub-rounded to sub-angular grains of quartz, with kaolin, ferromagnesian minerals and minor iron staining.

Objective : Recovery of glass-grade sand.

Processing : Screening at 850 μm followed by scrubbing and washing to remove kaolin slimes with magnetic separation of the minus 850 plus 100 μm fraction.

Results : Beneficiated product analyzed 99.70% SiO_2, 0.01% Fe_2O_3, 0.12% Al_2O_3.

Potential Use : Suitable as source material for sandblast applications, as foundry sand, and for manufacturing clear glass and silicon carbide.

Identification : **Ont. – 34** (Ref. No. 131)

Report – Title : EVALUATION OF SYLVANIA SANDSTONE FROM AMHERSTBURG AS GLASS SAND

– Author(s) : J. Leung

– No. and Date : CANMET, *Internal Report* 80–7, 1980.

Sample Description : Very friable dolomitic sandstone analyzing 94.7% SiO_2, 0.69% Fe_2O_3, 0.09% Al_2O_3, 1.36% CaO, 0.89% MgO, 2.52% L.O.I.

Objective : Evaluation as a potential source of glass–grade sand.

Processing : Wet screening at 600 and 100 μm to remove coarse and fine impure fractions. The minus 600 plus 100 μm fraction was treated by vigorous attrition scrubbing and washing, and the product was acid leached to further reduce iron oxide and dolomite.

Results : Attrition scrubbing, washing and acid leaching produced a product analyzing 0.02% Fe_2O_3, 0.11% CaO and 0.09% MgO.

Potential Use : Suitable for manufacturing clear glass.

Identification : **Ont. – 35** (Ref. No. 1)

Report – Title : CANADIAN SILICA RESOURCES: A STUDY OF THE PROCESSING OF ONTARIO POTSDAM SANDSTONE FOR GLASS AND FOUNDRY SAND

– Author(s) : R.K. Collings and P.R.A. Andrews

– No. and Date: CANMET, *Division Report* 83–43 (IR)

Sample Description : Selected deposits of Potsdam sandstone drill core samples from the Ottawa–Kingston area analyzing 84.6 to 98.5% SiO_2, 0.09 to 0.65% Fe_2O_3, and 0.07 to 2.10% Al_2O_3. The core was largely composed of white to grey, relatively tough sandstone with minor pyrite, iron oxides, feldspar, kaolin, calcite, dolomite, graphite and minor staining on quartz grains.

Objective : Evaluation as potential sources of glass and foundry sand.

Processing : Crushing to 600 μm, mulling, scrubbing, washing, flotation, magnetic separation and acid leaching.

Results : Flotation products analyzed 98.5 to 99.7% SiO_2, 0.022 to 0.156% Fe_2O_3 and 0.07 to 0.62% Al_2O_3. Leaching of selected samples further reduced iron and titanium oxides to 0.026% Fe_2O_3 and to 0.03% TiO_2.

Potential Use : Six of the seven deposits studied have potential as sources of sand for manufacturing clear glass. These deposits were in Lanark, Leeds, and Frontenac counties in the Smiths Falls–Kingston area.

Identification : **Ont. – 36** (Ref. No. 132)

Report – Title : FLOTATION STUDY OF NELLES CORNERS SILICA

– Author(s) : S.E. Erickson, American Cyanamid Co.

– No. and Date: *Report* (unnumbered), 1938.

Sample Description : A sample of 100 to 150 mm lumps of friable, calcareous sandstone with some iron staining analyzing 0.15% Fe, 0.56% Al_2O_3, 1.5% CaO.

Objective : Evaluation as a potential source of glass–grade sand.

Processing : Grinding to 99% minus 420 μm followed by flotation.

Results : Calcareous impurity was successfully reduced, and the final concentrate analyzed 0.06% Fe, 0.06% MgO, 0.085% CaO with a recovery of 81.5%. However, iron content at 0.06% Fe is well in excess of the glass–sand specification of 0.025% Fe_2O_3.

Potential Use : Suitable for manufacturing coloured glass.

Identification : **Ont. – 37** (Ref. No. 133)

Report – Title : TESTWORK ON BELLS CORNERS SANDSTONE
– Author(s) : F.W. Huggins
– No. and Date: *Report* (unnumbered), 1950.

Sample Description : A 250 t sample of Nepean (Potsdam) sandstone analyzing 97.5% SiO_2, 0.116% Fe_2O_3, 0.76% Al_2O_3 containing pyrite, marcasite and feldspar. The sandstone bed was reported to be 3 m thick, to contain 7 Mt and to be overlaid by calcareous sandstone.

Objective : Evaluation as a potential source of glass–grade sand.

Processing : Autogenous grinding, removal of fines, magnetic separation, roasting followed by magnetic separation.

Results : Autogenous grinding and magnetic separation recovered 70 to 80% of the material analyzing 98.76% SiO_2, 0.057% Fe_2O_3, 0.73% Al_2O_3. Subsequent roasting followed by magnetic separation improved the quality of sand indicating an analysis of 99.30% SiO_2, 0.027% Fe_2O_3, 0.17% Al_2O_3.

Potential Use : Suitable for manufacturing clear glass.

Identification : **Ont. – 38** (Ref. No. 134)

Report – Title : BENEFICIATION OF SAND FROM CAYUGA
– Author(s) : R. Rothfuss, Ortech International, Mississauga, Ont.
– No. and Date: *Report* 0–69329, 1969.

Sample Description : Sand composed of clean, well–rounded grains of quartz with calcite and clay as principal impurities.

Objective : Evaluation as a potential source of glass–grade sand.

Processing : Attrition scrubbing and washing to remove slimes, flotation of minus 420 plus 100 μm product to remove calcite with acid leaching to remove residual calcite; dry high intensity magnetic separation.

Results : Beneficiated product satisfactory for use as glass sand.

Potential Use : Suitable for manufacturing clear glass.

Identification : **Ont. – 39** (Ref. No. 135)

Report – Title : GANANOQUE SILICA INVESTIGATION
– Author(s) : F.G. Breyer and E.H. Hilgeman, for St. Lawrence Industrial Silica Ltd.
– No. and Date: *Preliminary Report* 1956; final report 1958.

Sample Description : A viable sample of diamond drill core sandstone analyzing >90% SiO_2, fine to medium–sized grains, siliceous bonding, minor limonite and carbonate.

Objective : Evaluation as potential source of glass and foundry sand.

Processing : Grinding to natural grain size by Aerofall milling, screening at 850 μm, attrition scrubbing and washing, blending to produce various sizes of foundry sand, roasting and acid leaching; laboratory and pilot–plant scale testing.

Results : Beneficiated product analyzed 0.02% Fe_2O_3, 0.1% Al_2O_3.

Potential Use : Suitable for glass, artificial abrasives and foundry applications.

Identification : **Ont. – 40** (Ref. No. 136)

Report – Title : RECOVERY OF GLASS SAND FROM BATH AREA POTSDAM SANDSTONE
– Author(s) : Lakefield Research, Lakefield, Ont.
– No. and Date: *Lakefield Research Report* 2333, 1981.

Sample Description : Drill core samples of Potsdam sandstone analyzing 85 to 90% SiO_2, 0.60 to 1.00% Fe_2O_3, and 1.5 to 5.0%Al_2O_3.

Objective : To evaluate as source material for glass sand.

Processing : Processing included crushing, sizing, magnetic separation, flotation and acid leaching.

Results : The iron oxide content of the beneficiated products was 0.03 to 0.07% Fe_2O_3, and recoveries were 50 – 70%, indicating unsuitability of this deposit as an economic source of glass sand.

Potential Use : Possibly suitable for manufacturing coloured glass.

Manitoba

Identification : **Man. – 1** (Ref. No. 140)

Report – Title : BENEFICIATION OF BLACK ISLAND SAND
– Author(s) : R.K. Collings
– No. and Date : CANMET, *Industrial Minerals Report* 358, 1955.

Sample Description : A 250 kg sample of sand with rounded to sub–angular grains with minor kaolin and ferromagnesian minerals analyzing 99.04% SiO_2, 0.012% Fe_2O_3, 0.562% Al_2O_3.

Objective : Evaluation as potential source of glass–grade sand.

Processing : Attrition scrubbing and washing to remove adhering kaolin; dry magnetic separation.

Results : Beneficiated sand analyzed 99.83% SiO_2, 0.006% Fe_2O_3, 0.04% Al_2O_3.

Potential Use : Suitable for manufacturing clear glass. Sand could also be used in foundry moulding and for fracturing oil–bearing formations.

Identification : **Man. – 2** (Ref. No. 141)

Report – Title : BENEFICIATION OF DEER ISLAND SAND
– Author(s) : R.A. Wyman
– No. and Date : *CANMET Project* MIL 349.

Sample Description : Various drill core samples of clay–bonded, loosely consolidated sandstone with rounded to sub–rounded grains.

Objective : Evaluation as a potential source of glass sand.

Processing : Attrition scrubbing and washing to reduce samples to grain size, washing to remove clay, high–intensity magnetic separation.

Results : Beneficiated sands were of high purity and considered suitable for use in applications requiring glass–grade silica.

Potential Use : Suitable for manufacturing clear glass.

Identification : **Man. – 3** (Ref. No. 3)

Report – Title : CANADIAN SILICA RESOURCES: A STUDY OF THE PROCESSING OF SELECTED SILICA SAMPLES FROM N.S., N.B., MAN., SASK. AND B.C.

– Author(s) : R.K. Collings and P.R.A. Andrews

– No. and Date: CANMET, *Division Report* 86–50 (IR), 1986.

Manitoba Samples

Sample Description : Samples from three locations:
Beausejour, 60% as clear quartz grains analyzing 88.7% SiO_2, 0.40% Fe_2O_3, 2.95% Al_2O_3, 2.66% LOI.

Swan River as sub–angular grains, analyzing 97.2% SiO_2, 0.39% Fe_2O_3, 1.01% Al_2O_3, 0.37% LOI.

Pine River as sub–rounded grains analyzing 98.8% SiO_2, 0.16% Fe_2O_3, 0.41% Al_2O_3, 0.30% LOI.

Mineralogy : Impurities included iron–stained quartz, kaolin, calcite, sphene, mica, feldspar, ilmenite, rutile, barite, pyrite and zircon.

Objective : To evaluate as glass and foundry sand.

Processing : Screening, agglomerate reduction, attrition scrubbing and washing, magnetic separation and flotation.

Results :

Sample	Product Analysis				Recovery, Wt %
	SiO_2	Fe_2O_3	Al_2O_3	LOI	
Beausejour	93.0	0.08	2.24	1.11	80
Swan River	99.5	0.05	0.11	0.16	90
Pine River	98.8	0.05	0.09	0.20	86

Potential Use : Swan and Pine River deposits have potential for manufacturing clear glass and all three are of interest for use as foundry sand.

Saskatchewan

Identification : **Sask. – 1** (Ref. No. 147)

Report – Title : FOUNDRY POTENTIAL OF RED DEER RIVER SAND
– Author(s) : A.E. Murton
– No. and Date : CANMET *Ore Dressing Investigation Report* 2088, 1946.

Sample Description : Washed and unwashed sand, minus 850 μm in size, and sub–angular grain shape.

Objective : Evaluation as foundry, moulding and core sand.

Processing : Removal of plus 600 μm by screening, followed by foundry moulding and core testing.

Results : Minus 600 μm fraction is suitable as foundry and moulding sand but was not very satisfactory as core sand.

Potential Use : Suitable as foundry and moulding sand.

Identification : **Sask. – 2** (Ref. No. 148)

Report – Title : BENEFICIATION OF SILICEOUS SAND FROM RED DEER RIVER
– Author(s) : H.L. Beer
– No. and Date : CANMET *Ore Dressing Investigation Report* 2198, 1947.

Sample Description : Two samples:
No. 1 – rounded to sub–angular quartz with much iron staining and kaolin pitting with trace ilmenite and sericite, 95.3% minus 850 μm in size and analyzing 98.50% SiO_2, 0.14% Fe_2O_3, 0.54% Al_2O_3, 0.22% TiO_2
No. 2 – rounded to angular quartz with iron staining and carbonaceous material with trace limonite, ilmenite, and sericite 95.0% minus 850 μm in size and analyzing 97.40% SiO_2, 0.073% Fe_2O_3, 0.93% Al_2O_3, 0.056% TiO_2

Objective : Evaluation as a potential source of glass–grade sand.

Processing : Screening, washing, tabling.

Results : Beneficiated products from both samples were suitable for glass manufacture; sample 2 analyzed 99.65% SiO_2, 0.027% Fe_2O_3, 0.027% TiO_2 and recovery was 85%.

Potential Use : Suitable for manufacturing clear glass.

Identification : **Sask. - 3** (Ref. No. 149)

Report - Title : RECOVERY OF GLASS SAND FROM ERWOOD SAND (RED DEER RIVER)

- Author(s) : R.K. Collings
- No. and Date: CANMET, *Industrial Minerals Report* 221, 1953.

Sample Description : Two samples:
N-1, greyish white, fine-grained quartz with minor muscovite, feldspar and hornblende; 99.7% minus 300 μm in size and analyzing 0.057% Fe_2O_3, 0.87% Al_2O_3.
S-1, greyish white, coarse sand with minor feldspar, mica and hornblende; 100% minus 1.2 mm in size and analyzing 0.045% Fe_2O_3, 0.67% Al_2O_3.

Objective : Evaluation as potential sources of glass-grade sand.

Processing : Attrition scrubbing, washing, magnetic separation and flotation.

Results : Flotation concentrates analyzed:

N-1, 99.02% SiO_2, 0.015% Fe_2O_3, 0.20% Al_2O_3
S-1, 99.14% SiO_2, 0.013% Fe_2O_3, 0.19% Al_2O_3

Potential Use : Suitable for manufacturing clear glass.

Identification : **Sask. - 4** (Ref. No. 150)

Report - Title : INVESTIGATION OF SAND FROM WAPAWEKKA LAKE

- Author(s) : R.K. Collings
- No. and Date: CANMET, *Industrial Minerals Report* 455, 1957.

Sample Description : A 5 kg sample of minus 210 μm, fine-grained, light grey-brown sand containing minor muscovite, feldspar, clay and ferromagnesian minerals.

Objective : Evaluation as a potential source of glass-grade sand.

Processing : Washing to remove clay slimes; dry magnetic separation.

Results : The resulting product analyzed 97.88% SiO_2, 0.16% Fe_2O_3, 0.80% Al_2O_3

Potential Use : Possibly suitable for manufacturing clear glass with further beneficiation to reduce iron oxide and alumina; fineness and angularity of grains would limit use as a foundry sand.

Identification : **Sask. – 5** (Ref. No. 3)

Report – Title : CANADIAN SILICA RESOURCES: A STUDY OF THE PROCESSING OF SELECTED SILICA SAMPLES FROM N.S., N.B., MAN., SASK. AND B.C. FOR GLASS AND FOUNDRY SAND

– Author(s) : R.K. Collings and P.R.A. Andrews

– No. and Date: CANMET, *Division Report* 86–50 (IR), 1986.

Saskatchewan Samples (Red Deer River)

Sample Description : White to buff–coloured quartz sand, coarse to fine with a sub–angular grain shape. Principal minor minerals included kyanite, garnet, mica and feldspar. The samples analyzed 98.0 – 98.2% SiO_2, 0.06 – 0.09% Fe_2O_3, 0.67 – 0.78% Al_2O_3, 0.27 – 0.34% LOI.

Objective : Evaluation as source of glass and foundry sand.

Processing : Attrition scrubbing, washing, magnetic separation and flotation.

Results :

Sample	**Product Analysis**				**Recovery, Wt %**
	SiO_2	Fe_2O_3	Al_2O_3	LOI	
Upper Strata	99.0	0.03	0.19	0.15	89
Lower Strata	99.0	0.04	0.33	0.22	88

Potential Use : Suitable for manufacturing clear glass and as foundry sand.

Alberta

Identification : **Alta. - 1** (Ref. No. 153)

Report - Title : ATHABASCA TAR SANDS
- Author(s) : S.C. Ells
- No. and Date: CANMET *Ore Dressing Investigation Report* 632, 1926.

Sample Description : Rounded to sub-angular sand grains containing minor feldspar and residual bitumen analyzing 95.5% SiO_2, 0.35% Fe_2O_3, 2.25% Al_2O_3.

Objective : Evaluation as foundry and moulding sand.

Processing : None reported, probably washing and sizing.

Results : Sand was too fine and not sufficiently refractory for steel-foundry use, also too low-grade for use as glass sand.

Potential Use : Probably unsuitable for most silica uses.

Identification : **Alta. - 2** (Ref. No. 154)

Report - Title : MOULDING PROPERTIES OF ATHABASCA TAR SAND RESIDUE
- Author(s) : A.E. Murton
- No. and Date: CANMET *Physical Metallurgy Report* 285, 1949.

Sample Description : Rounded and smooth sand residue containing 1.5% bitumen with minor feldspar.

Objective : Evaluation as foundry moulding sand.

Processing : Foundry moulding and casting tests.

Results : The low sintering point (1405°C), due to the presence of feldspar impurity, would render this sand unsuitable for steel moulding and casting, but satisfactory for iron and non-ferrous work. The sand is also too fine for most foundry-sand systems (92.7% minus 210 plus 75 μm).

Potential Use : Limited to only a few applications.

Identification : **Alta. – 3** (Ref. No. 155)

Report – Title : EVALUATION OF PEACE RIVER SILICA SAND AS FOUNDRY SAND
– Author(s) : A.E. Murton
– No. and Date : CANMET, *Physical Metallurgy Report* 10103, 1955.

Sample Description : A sample of minus 850 μm, rounded to sub–angular quartz sand with minor feldspar.

Objective : Evaluation as foundry, moulding and core sand.

Processing : Foundry, moulding and core tests.

Results : The sand was sufficiently refractory (sintered at 1543°C) for use as foundry sand as well as moulding and core sand, although slightly coarse at AFS 45. The coarseness could be reduced to the desired AFS 55 to 70 by screening and removal of the coarser, plus 600 to 420 μm fractions.

Potential Use : Suitable for foundry, moulding and core sand applications.

Identification : **Alta. – 4** (Ref. No. 156)

Report – Title : BENEFICIATION ATHABASCA TAR SAND TAILINGS
– Author(s) : F.H. Hartman
– No. and Date : CANMET, *Investigation Report* 66–38, 1966.

Sample Description : 500 kg of bituminous sand tailings with minor clay, mica and carbonaceous material analyzing 98.40% SiO_2, 0.10% Fe_2O_3, 0.80% Al_2O_3.

Objective : Evaluation as a potential source of glass–grade sand.

Processing : Screening at 420 μm to remove bitumen–bonded sand agglomerates; scrubbing, screening, and flotation of tar from sand in various size fractions, wet magnetic separation, ultrasonic cleaning.

Results : Best results were produced with the minus 210 μm sand fraction by ultrasonic cleaning, when the iron oxide was reduced to 0.04%. This size of sand normally is too fine for use in glass manufacture and the iron oxide content is slightly high.

Potential Use : Unsuitable for manufacturing clear glass.

Identification : **Alta. - 5** (Ref. No. 157)

Report - Title : BENEFICIATION OF ALBERTA TAR SANDS
- Author(s) : E.O. Lilge, Canadian Chemical and Process Industries
- No. and Date: *Report* (unnumbered), 1945.

Sample Description : Sand tailings from Albasand Oils Ltd., essentially quartz with bituminous tar, mica and minor iron and titanium oxides analyzing 98.83% SiO_2, 0.04% Fe_2O_3, 0.81% Al_2O_3.

Objective : Recovery of glass-grade sand.

Processing : Tabling to remove mica and magnetic separation to remove iron oxide minerals.

Results : The resulting product analyzed 0.033% Fe_2O_3 and 0.051% TiO_2. The high TiO_2 content and fineness of this sand would make it unsuitable for use in glass manufacture.

Potential Use : Unsuitable for manufacturing clear glass.

British Columbia

Identification : **B.C. – 1** (Ref. No. 158)

Report – Title : BENEFICIATION OF SILICA FROM GOLDEN
– Author(s) : R.K. Collings
– No. and Date: CANMET, *Investigation Report* 59–1, 1959.

Sample Description : Two samples, A and B, each consisting of a 40:60 mixture of sand and friable sandstone up to 100 mm in size.
A – 40 kg, iron–stained, yellow to brown quartz with a rounded grain shape analyzing 99.46% SiO_2, 0.25% Fe_2O_3, 0.06% Al_2O_3
B – 40 kg, light–brown quartz with a rounded grain shape analyzing 99.69% SiO_2, 0.04% Fe_2O_3, 0.07% Al_2O_3.

Objective : Evaluation as a potential source of glass–grade sand.

Processing : Crushing to pass 850 μm to reduce agglomerates, attrition scrubbing and washing to remove clay slimes, dry magnetic separation.

Results : Products analyzed:
A – 99.71% SiO_2, 0.08% Fe_2O_3, 0.033% Al_2O_3
B – 99.83% SiO_2, 0.02% Fe_2O_3, 0.04% Al_2O_3 with a recovery of 95%.

Potential Use : Sample A possibly suitable for manufacturing clear glass, but would require further processing to reduce the iron oxide content.
Sample B suitable for clear glass manufacture.

Identification : **B.C. – 2** (Ref. No. 159)

Report – Title : BENEFICIATION OF SILICA FROM CANAL FLATS
– Author(s) : F.H. Hartman
– No. and Date: CANMET, *Investigation Report* 62–71, 1962.

Sample Description : White sandstone with a natural grain size of 600 μm.

Objective : Evaluation as a potential source of glass–grade sand.

Processing : Simulated autogenous grinding to reduce sandstone to its natural grain size.

Results : The minus 600 μm product analyzed 99.20% SiO_2, 0.02% Fe_2O_3, 0.28% Al_2O_3.

Potential Use : Suitable for manufacturing clear glass, although slightly high in alumina and low in silica. It could be used as sandblast sand and probably would be of interest for foundry–moulding purposes.

Identification : **B.C. – 3** (Ref. No. 160)

Report – Title : EVALUATION OF SILICA SAND FROM GOLDEN
– Author(s) : P.R.A. Andrews
– No. and Date : CANMET, *Division Report* 85–7 (IR), 1985.

Sample Description : High–grade processed quartz sand product, minus 630 plus 100 μm in size with trace calcite, dolomite, mica, ankerite, kaolin, zircon, pyroxenes, sericite, hematite, biotite, goethite and pyrite, analyzing 99.53% SiO_2, 0.075% Al_2O_3, 0.0219% Fe_2O_3.

Objective : Production of high–value silica for specialty use (<15 ppm combined Fe_2O_3 and Al_2O_3).

Processing : Flotation, high intensity magnetic separation and acid leaching of the flotation concentrate ground to 53 μm.

Results : Iron oxide was reduced to 70 ppm and alumina to 440 ppm by magnetic separation and flotation. Acid leaching of the ground flotation concentrate reduced the iron oxide content a further 20%, to 56 ppm Fe_2O_3.

Potential Use : Unsuitable for specialty use.

Identification : **B.C. – 4** (Ref. No. 3)

Report – Title : CANADIAN SILICA RESOURCES: A STUDY OF THE PROCESSING OF SELECTED SILICA SAMPLES FROM N.S., N.B., MAN., SASK. AND B.C. FOR GLASS AND FOUNDRY SAND
– Author(s) : R.K. Collings and P.R.A. Andrews
– No. and Date : CANMET, *Division Report* 86–50 (IR), 1986.

British Columbia Sample (Campbell River)

Sample Description : Low–grade beach sand with quartz and feldspar as the major minerals. The quartz occurred as sub–angular grains, and minor minerals included amphibole, chlorite, garnet, ilmenite, pyrite and iron oxide. The head analysis was 70% SiO_2, 3.24% Fe_2O_3, 13.20% Al_2O_3, 1.05% LOI.

Objective : Evaluation as a source of glass and foundry sand.

Processing : Attrition scrubbing, washing, magnetic separation and flotation.

Results : Results were poor, product analysis was only 79% SiO_2, 0.17% Fe_2O_3, 11.60% Al_2O_3, and the weight recovery only 55%.

Potential Use : Unsuitable for manufacturing clear glass and of limited interest only for foundry–moulding applications.