

CHAPTER 10. SILICA

Silicon is the most abundant element on the earth's surface and in the form of silica (SiO_2) has a hardness of 7 on Mohs scale, a density of 2.65 and is insoluble in all acids except HF (Berry and Mason, 1959). Silica is usually colourless to white, but can occur in practically any shade.

USES

Silica has many industrial applications in abrasives and polishes, glass manufacture, fillers and extenders, silica brick manufacture, as a catalyst, in specialty coatings, cleansers, ceramics, electronics, optics and refractories, in ferro-silicon manufacture, rubber and as a frac sand (MacDonald, 1991).

Processing silica of specific quality yields several kinds of specialty silicas. These include colloidal, fumed, fused, high purity ground, silica gel and precipitated silica.

Colloidal silica is used mainly as a high temperature binder for silicon wafer polishing and carbonless paper. **Fumed silica**, because of its unique strength, thixotropic properties and flattening properties, is a valuable ingredient in rubber, plastics, cement, specialty coatings, adhesives, sealants, pesticides, cosmetics, pharmaceuticals, defoamers, inks, abrasives and batteries.

Fused silica is produced by fusion of very high quality silica sand feedstock in electric arc and resistance furnaces. The resulting product is very different from the original silica sand due to the extremely high quality, consistent chemistry, high resistance to thermal shock and low thermal conductivity. Fused silica is therefore suitable as a filler for electronic encapsulants, refractory and investment castings and specialty coatings.

High purity ground silica is produced from silica sand or soft, friable rocks and is often referred to as amorphous silica. It is used mainly in specialty coatings, plastics, rubber, electronics, abrasives, refractories and optics depending on average particle size, distribution, hardness and refractive index.

Silica gel is an extremely pure, porous and amorphous form of silica known for a high degree of internal surface area, hardness, uniformity and chemical inertness. Its ability to absorb liquids makes it valuable in a wide variety of applications including catalysts, anticaking agents in food and pharmaceutical products, desiccants, cosmetics, plastics, specialty coatings, paper and adhesives.

Precipitated silica is another kind of specialty silica which is mainly used as a reinforcing agent in tire compounds. Its properties also provide anticaking, conditioning, suspension and viscosity control in products such as toothpastes, deodorants, nail polishes and vitamin tablets.

Current prices for the various forms of these specialty silicas range from \$140 (Cdn) per tonne to over \$6500 (Cdn) per tonne (Harris et al., 1987).

As expected, world resources of silica are immense with the extremely high grade deposits near markets the most sought after. The future demand for silica products should remain high especially in specialty silica applications. Increased growth in the ceramics industry related to utilizing more ceramic components in automobile engines is one area of expected growth.

NOVA SCOTIA POTENTIAL

Silica occurs both in rock and granular forms. Deposits are common throughout most areas of Nova Scotia. Silica rock occurrences with economic potential are found in quartzites of the Hadrynian George River Group of Cape Breton Island as well as orthoquartzites of the Silurian-Devonian White Rock Formation of southwestern Nova Scotia. Quartz veins with economic potential occur within Cambro-Ordovician Meguma Group rock which comprises 16 317 km² of the southern portion of mainland Nova Scotia. High silica content sandstones with economic potential occur in Early Carboniferous Horton Group rocks which occur in central and northern Nova Scotia.

Granular deposits of white silica sand of Cretaceous age occur in Windsor Group fault-bound basins in the Shubenacadie, Musquodoboit and Stewiacke Valleys on mainland Nova Scotia and at Glen Brook (Diogenes Brook, historical name), Inverness County, Cape Breton Island (Dickie, 1986). Other granular deposits are found in isolated sinkholes and unconformity fillings within or adjacent to Windsor Group carbonate rocks, as ice contact deposits throughout the Province and beach deposits along the coast.

Nova Scotia Silica Rock Deposits

There are many occurrences of quartzite throughout Nova Scotia and many grades are available. Quartzite is a metamorphosed sandstone made up chiefly of quartz sand united by a siliceous cement to form hard, low porosity rock. The colour of Nova Scotia quartzite

varies from white to grey with a few occurrences tinted various shades of brown, red or yellow due to the presence of small amounts of impurities. There are a few high grade, silica-rich, quartzite deposits in Nova Scotia.

The Chegoggin Point, Yarmouth County, deposit contains minable reserves with SiO₂ percentages as high as >99.0% SiO₂ (Figs. 18, 19 and 32). This deposit occurs in the Silurian-Devonian White Rock Formation and was previously quarried for raw material to manufacture high grade silica brick by Dominion Steel Corporation for use in its steel plant at Sydney, Nova Scotia. During the period from 1947-1963, approximately 100 000 t of silica ore were extracted on a seasonal basis (Taylor, 1967). The ore far exceeded specifications for silica brick manufacture. The deposit consists of wide beds of orthoquartzite contained within a metasedimentary and metavolcanic sequence. The quartzite is fused, extremely hard and has been injected with veins of pure secondary quartz. The beds are lenticular and pinch and swell along strike. A recent diamond-drill hole (Fig. 18) (CH-LG-87-6; MacDonald, 1990d) near the coastline intersected quartzite beds with a total thickness in excess of 61 m. A cross-section of this drillhole is shown in Figure 33. The quartzite beds appear to be discontinuous and displaced at locations along strike. A previous Nova Scotia Department of Mines drillhole (Jones, 1963) intersected similar quartz-

ite beds with a total thickness in excess of 60 m, 16 km northeast on the western shore of Lake George, Yarmouth County. It is estimated that a reserve in excess of 9 Mt of high grade silica occurs in steeply dipping beds of quartzite which extend inland from Chegoggin Point approximately 5 km. Shipping possibilities for this material are enhanced by the availability of 12 m of tidewater at Chegoggin Point. Chemical analysis of this deposit and others appears in Table 15.

Associated with the silica beds and exposed along the coast, are beds of garnet-schist containing 40-50% almandine garnets over widths of 3.5-4.5 m. Preliminary tests indicate the garnets are of excellent abrasive quality and can be concentrated by simple gravity separation (Appendix 1).

Quartzite beds of the White Rock Formation extend intermittently from Chegoggin Point, Yarmouth County, to New Minas, Kings County, a distance of over 200 km. The SiO₂ content of the quartzite is 96-97% at White Rock, Kings County, where the quartzite is quarried and crushed and used to make 'tilt-up' building panels, a popular, modern building technique.

MacDonald (1990d) detailed the exploration, geophysical and drilling programs conducted on the Chegoggin Point-Lake George silica and garnet deposit during this Various Commodities Project.

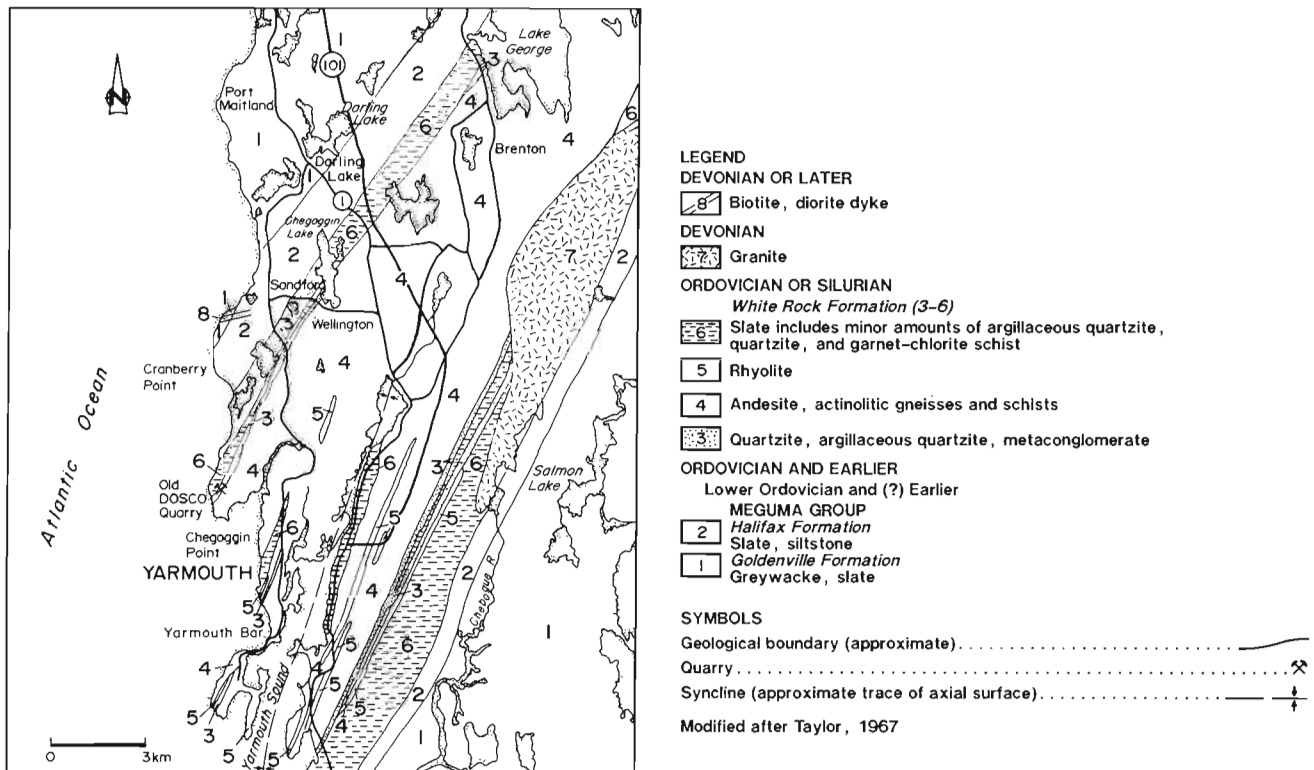


Figure 32. Geological map for the Chegoggin Point, Lake George, Yarmouth County, area.

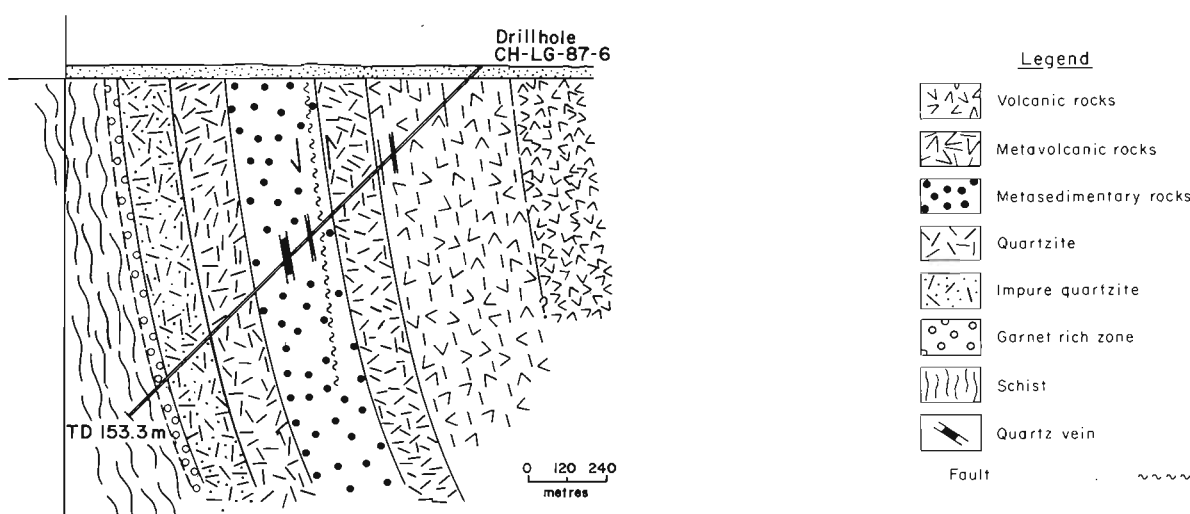


Figure 33. Cross-section of drillhole CH-LG-87-6 through high grade silica quartzite beds at Chegoggin Point, Yarmouth County. See Figure 18 for location.

Table 15. Chemical analysis of selected, high potential silica deposits throughout Nova Scotia.

Deposit Location	Type	%							
		SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	MnO	S	TiO ₂
Chegoggin Point, ¹ Yarmouth County	Quartzite	99.70	0.02	0.25	0.012	<0.002	0.002	0.024	n/a
	(white)	99.60	0.002	0.35	0.018	<0.002	0.002	0.02	n/a
	Quartzite (dark brown)	98.82	0.38	0.33	0.014	0.007	0.003	0.024	n/a
White Rock Mills, ¹ Kings County	Quartzite	90.70	0.11	3.24	2.03	2.11	nil	n/a	n/a
	(white to pale yellow to pale brown)	95.01	2.27	1.77	nil	nil	0.13	n/a	n/a
Diogenes Brook, ² Inverness County	Sand (over 27 m)	96.45	1.27	1.04	n/a	n/a	n/a	0.008	0.12
	Sand (over 18 m)	96.23	1.25	1.17	n/a	n/a	n/a	0.01	0.01
Leitches Creek, ³ Cape Breton County	Quartzite	97.22	1.75	0.40	0.30	0.18	n/a	n/a	n/a
George River, ⁴ Cape Breton County	Quartzite (average of 7 samples)	96.91	0.66	1.36	0.12	0.27	n/a	n/a	n/a
Aberdeen, ⁴ Inverness County	Sandstone	96.09	2.15	0.49	0.10	0.38	n/a	n/a	n/a
Skye Mountain, ⁴ Inverness County	Quartzite	97.37	1.34	0.48	0.12	0.11	n/a	n/a	n/a
Iron Mines, ⁴ Inverness County	Quartzite	97.66	1.39	0.40	0.10	0.20	n/a	n/a	n/a
Brazil Lake, ⁵ Hants County	Sand	99.10	0.38	0.14	0.00	0.00	n/a	n/a	n/a
Hantsport, ⁶ Kings County	Sandstone	96.1	1.83	0.78	n/a	n/a	n/a	n/a	n/a

n/a not applicable.

¹author; analysis from Minerals Engineering Centre, Technical University of Nova Scotia.

²Dickie, 1986.

³Goranson, 1931.

⁴Wright, 1964.

⁵Fowler and Stea, 1980.

⁶Goudge, 1952.

On Cape Breton Island, high silica quartzite occurs in the Hadrynian George River Group metasedimentary rocks at Hunters Mountain, Victoria County, and Skye Mountain, Inverness County. A similar silica deposit at Leitches Creek, Cape Breton County, was quarried by the Dominion Steel Corporation in the early 1900s as a source of material for silica brick manufacture for its steel works at nearby Sydney (Fowler, personal communication). The better quality silica ore has been removed from this deposit.

Nova Scotia Silica Sand Deposits

High purity (+98% SiO₂) silica sand suitable for manufacturing glass bottles and fibreglas insulation as well as being suitable as a sandblasting media, occurs in many locations in Nova Scotia. The most notable deposits occur as sinkhole and fault bound Windsor basin fillings in the Musquodoboit and Shubenacadie Valleys and at Glen Brook, Inverness County. Present day silica sand production is from the West Indian Road, Hants County, deposit and from the Elmsdale deposit in the central Musquodoboit Valley. The West Indian Road deposit is a sinkhole filling comprised chiefly of sand and has been producing for many years. The Musquodoboit Valley deposits tend to be lenticular and thin within the Cretaceous section which is comprised of interbedded silica sand and kaolinitic clay (Dickie, 1986).

The silica sand deposit on Glen Brook, Inverness County, is located 3.2 km northwest of the Community of Melford (Fig. 34). Access to the property is provided by a logging road along the western side of Glen Brook from Trans-Canada Highway 105 at Melford, Inverness County. The deposit was worked during the late 1920s by the River Denys Sand and Clay Company, but little evidence of this activity remains (Dickie, 1986).

The silica sand was initially exposed in the stream bed by Glen Brook. The sand is now visible in old and recent excavations near the intersection of the two main tributaries of Glen Brook where up to 20 m thick deposits of ice contact stratified drift occur. The top of the silica sand appears to be flat lying and is approximately 5 m above the present stream level. The sand does not occur as high terraces on either side of the

steep stream valley walls and therefore only the top 5 m of the deposit could be removed above the water table.

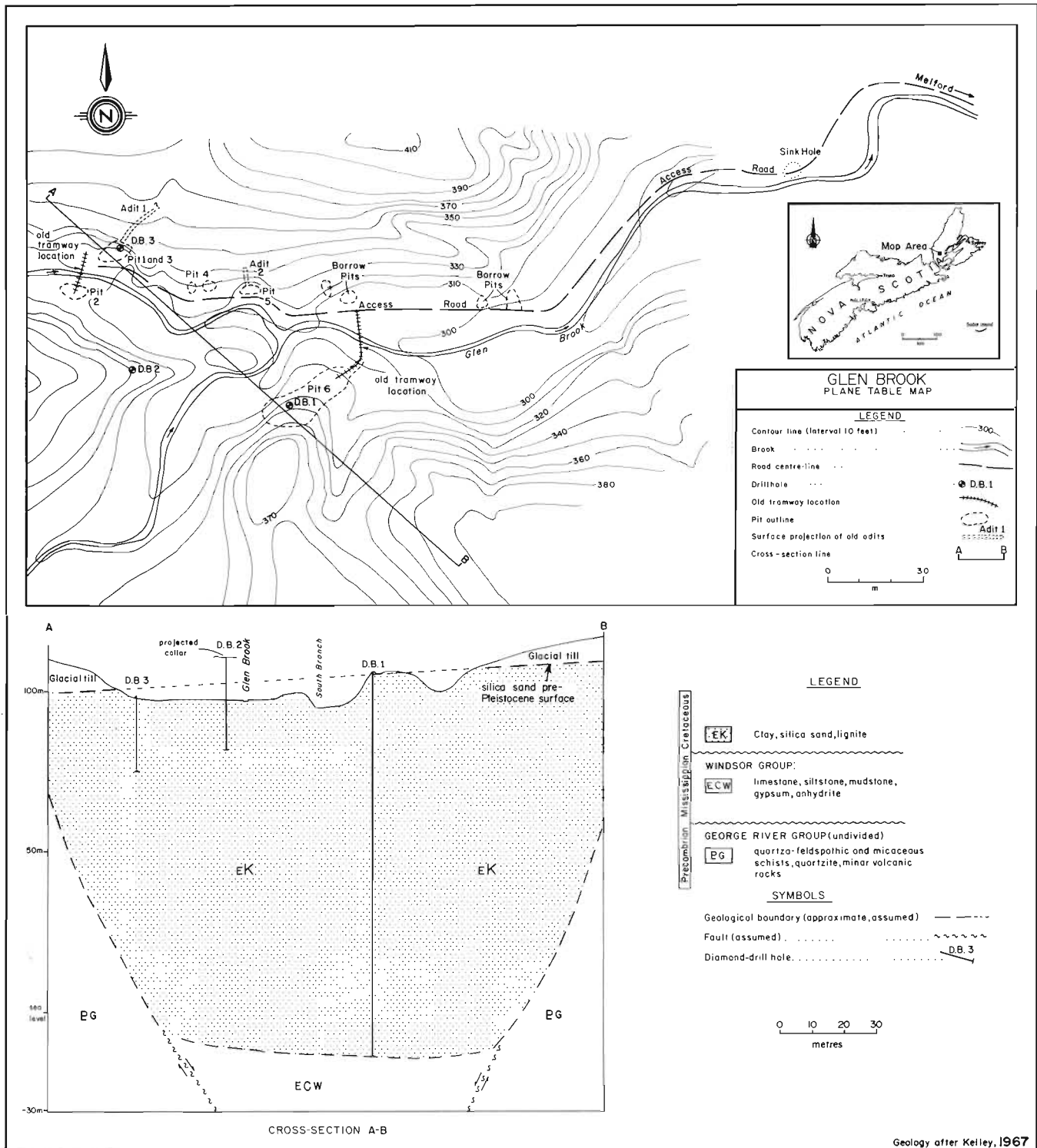
The Nova Scotia Department of Mines and Energy completed three diamond-drill holes on the deposit during 1982 (Dickie, 1986); two to test the overburden thickness and the third drillhole to determine the thickness of the deposit and to retrieve samples for analyses. The deposit consists of interbedded coarse and fine, white sand and clay. It is 125 m thick and overlies a white limestone breccia. At the surface, the bedding planes strike 180° and dip 40° east (Fig. 34). Analysis of the sand samples collected during the drilling program indicated that a possible 7 Mt of >95% SiO₂ are in situ at, and mostly under, Glen Brook (Dickie, 1986).

Nova Scotia Quartz Veins

Quartz is the most common mineral in Nova Scotia's gold districts making up 20-30% by volume in some deposits. The quartz veins reach widths in excess of 6 m at certain locations and are extremely high grade, massive, colourless to white and range from semitransparent to opaque. Wide quartz veins of this type are known to occur within the Meguma Group Terrane in southwestern Nova Scotia at Little Tobeatic Lake, Shelburne County, and Flintstone Rock, Yarmouth County (Fig. 35). They also occur near Country Harbour, Guysborough County, (Fig. 36) where SiO₂ values in the veins are in the 98-99% range. Quartz veins are common throughout the Meguma Terrane.

Nova Scotia High Silica Sandstone Deposits

High silica sandstone deposits are found in Early Carboniferous rocks of the Horton Group. The deposit with the best potential for development is located just west of Hantsport, Kings County (Fig. 37). Previous diamond drilling indicated a reserve of 100 000 t grading 96.1% silica (Goudge, 1952). Other known Horton Group silica-rich deposits of quartz arenite with SiO₂ percentages in the 83-90% range are located near Willowdale, McKinnon Lake and Lansdowne Station in Pictou County and near Sutherland Brook, Colchester County (Fig. 38).



Modified after Dickle, 1986

Figure 34. Plane table map and cross-section of Glen Brook (Diogenes Brook), Inverness County, silica sand deposit.

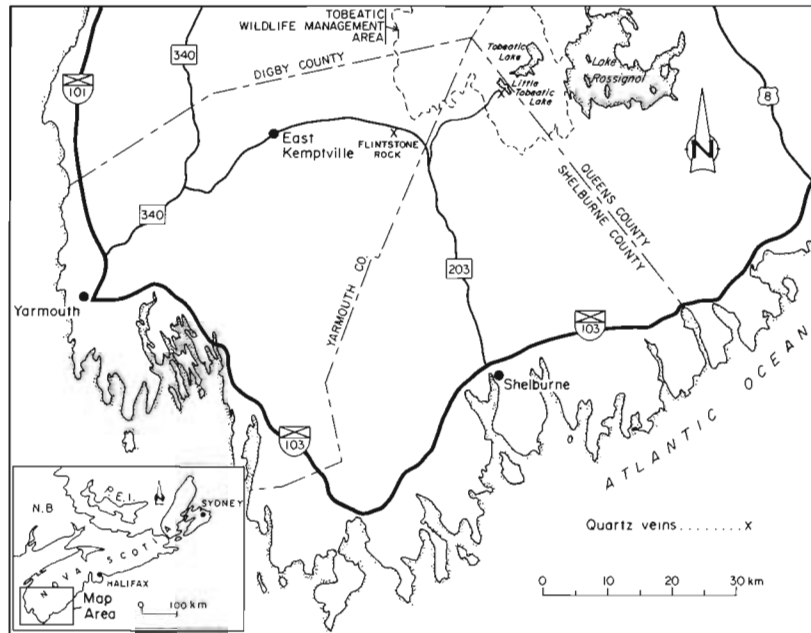


Figure 35. Map showing location of wide quartz veins at Flintstone Rock, Yarmouth County, and Little Tobeatic Lake, Shelburne County.

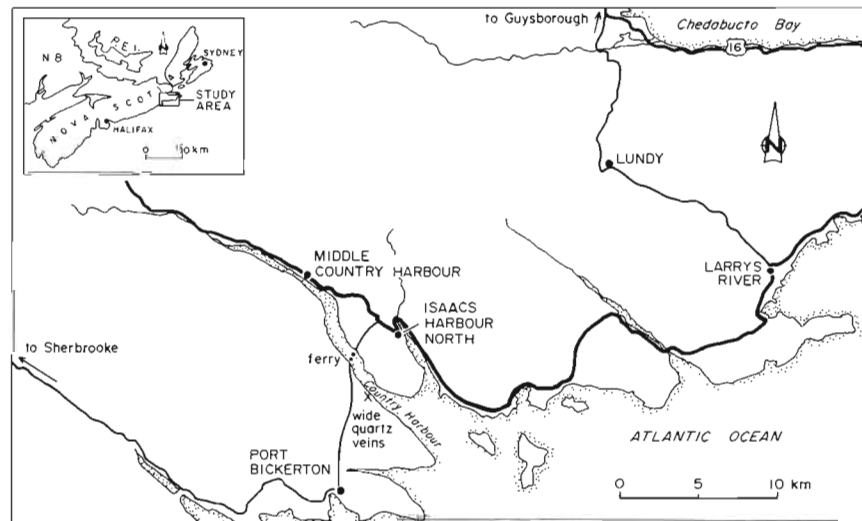


Figure 36. Location map showing area of wide quartz veins near Country Harbour, Guysborough County.

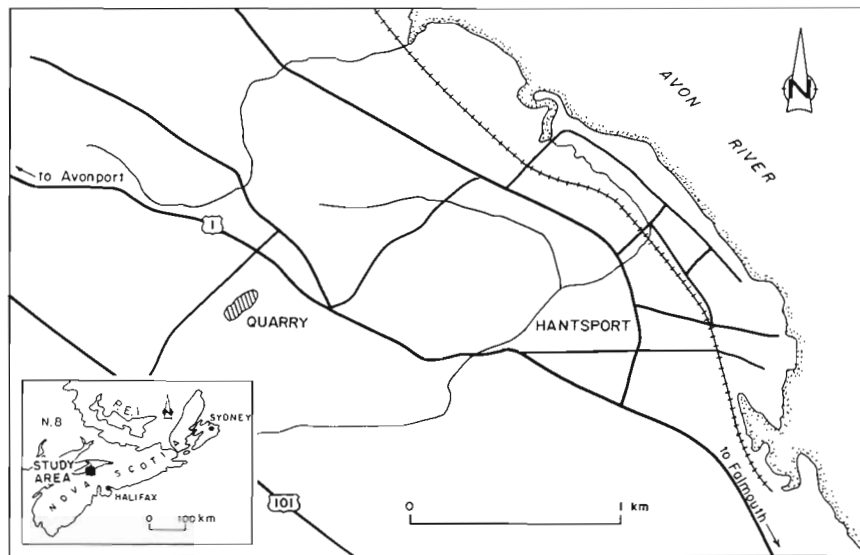


Figure 37. Location map showing old silica sandstone quarry and deposit near Hantsport, Hants County, where a proven reserve of 100 000 t grading 96.1% silica has been delineated by Goudge (1952).

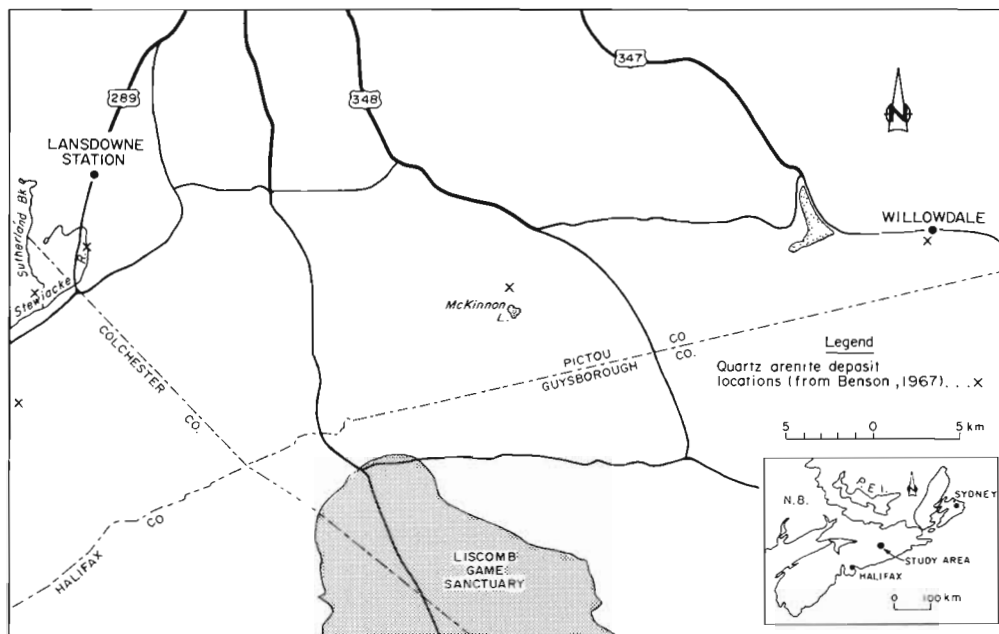


Figure 38. Location map showing silica-rich deposits of quartz arenite near Willowdale, McKinnon Lake and Lansdowne Station, Pictou County, and near Sutherland Brook, Colchester County.