CHAPTER 7. GARNET

Garnet is truly a unique mineral. Characteristics such as high hardness, sharp, consistent fracture, acid resistance, high specific gravity, nontoxicity and attractive colour are some of the factors which have resulted in the increasingly diverse use of garnet in industrial applications.

The garnets comprise a group of isomorphous minerals with the general formula $X_3Y_2(SiO_4)_3$ in which X may be Ca, Mg, Fe^2 or Mn^2, and Y may be Al, Fe^3 or Cr^3, sometimes in part Ti or Mn^3. Table 11 follows giving names used for the minerals with their components (Berry and Mason, 1959).

Table 11. Garnet minerals and their components.*

Species	Formula	Density
Almandite	$Fe_3Al_2(SiO_4)_3$	4.32
Pyrope	$Mg_3Al_2(SiO_4)_3$	3.58
Spessartite	$Mn_3Al_2(SiO_4)_3$	4.19
Grossularite	$Ca_3Al_2(SiO_4)_3$	3.59
Andradite	$Ca_3Fe_2(SiO_4)_3$	3.86
Uvarovite	$Ca_3Cr_2(SiO_4)_3$	3.78

*from Berry and Mason, 1959.

The composition of naturally occurring garnets seldom approaches the formulas given above, as a result of extensive atomic substitution. The specific name applied is that of the component present in the largest amount.

Garnets are typically minerals of metamorphic rocks, although they have been found in some igneous rocks. They are resistant to both mechanical and chemical breakdown and occur as detrital minerals in sands and sandstones. Specifically they differ somewhat in their mode of occurrence as summarized below:

Almandite: The common garnet of schists and gneisses is usually almandite. It may also be found in granites, rhyolites and pegmatites.

Pyrope: Less common than most other garnets, pyrope occurs in ultrabasic igneous rocks and serpentines derived from them, and in high grade magnesium-rich metamorphic rocks.

Spessartite: Garnets from granite pegmatites are often spessartite or intermediate between spessartite and almandite; spessartite also occurs in metamorphosed manganese bearing rocks.

Grossularite: Grossularite is typically formed by the contact or regional metamorphism of impure limestones and is thus often associated with calcite, wollastonite and idocrase. Grossularite commonly contains combined water, as a result of the partial substitution of $(OH)_4^{-4}$ for $(SiO_4)^{-4}$ in the structure.

Andradite: Andradite is formed by the metasomatic alteration of limestones by iron bearing solutions, and commonly occurs associated with ore deposits in calcareous rocks.

Uvarovite: Uvarovite is rare and occurs in association with chromite in serpentine.

USES

Traditionally, garnet has been an important medium to the abrasives industry. Garnet is one of the oldest natural abrasives known to man and has exceptional abrasive qualities which, despite advances in artificial abrasive technology, remain unequalled in many metal, glass and wood finishing applications. With energy costs for the production of artificial abrasives increasing, the demand for high quality, readily available natural garnet has risen sharply (Industrial Garnet Extractors, 1983).

Garnet has become the preferred media in many fluid filtration applications because of its resistance to acidic and chemical solutions, high specific gravity, efficient particle-trapping granular shape and low cost. Applications range from small, single-medium filters, such as swimming pools, to dual-media municipal and industrial systems, to technically advanced multi-media (garnet, quartz and anthracite) commercial systems.

The physical and chemical properties of garnet make it ideal for a wide variety of applications where skidding, slipping, high wear and acid exposure are problems. Garnet can be mixed with all types of resins, epoxies, paints, cements and other bonding agents to provide many desirable flooring, surfacing and coating characteristics.

Garnet is one of a very few minerals which has a high specific gravity, a high hardness, acid resistance and at the same time is abundant enough in nature to be

used in the various types of heavy media applications. Typical uses include special grouting cements for water wells; engineering and petroleum applications; low to medium level radiation shielding; and other situations where a high density-to-volume ratio is required (Toon, 1986).

WORLD SUPPLY

The United States is the largest garnet producer accounting for over 60% of the world's production; the remainder is produced primarily, in order of production by India, Australia, China and the U.S.S.R. (Austin, 1987). Within the United States there are three main producers, two in New York State and one in Idaho. The two New York operations are small with questionable reserves; the Idaho deposit hosts two mines and a single mill; a deposit in Maine is considered one of the largest in the world with an unusually high garnet concentration of 50-60% (Austin, 1987). This deposit produced briefly in 1989, but financial problems placed this operation in bankruptcy in 1990.

Annual world production is approximately 50 000-60 000 t with the United States accounting for approximately 35 000 t per year (Austin, 1987). World reserves of garnet are considered large.

NOVA SCOTIA POTENTIAL

There are many known occurrences of garnet within Nova Scotia. They are contained mainly in schists near intrusions of granite and in pegmatites cutting through the granite. These occurrences are documented in the Nova Scotia Department of Natural Resources mineral occurrence files and selected assessment reports.

The deposit, with perhaps the most potential, occurs as a garnetiferous graphitic micaceous schist found outcropping along the shoreline at Chegoggin Point, Yarmouth County (Fig. 18). Belonging to the White Rock Formation of Siluro-Devonian age, the strata cuts the coastline obliquely with a regional strike of N35°E and dipping 80°E to vertical. Numerous mica schist beds have been identified, some containing a few small garnets. One bed, averaging 3 m in thickness, is rich in almandite garnets.

During October 1987, a 2 t bulk sample was collected from the garnet-rich schist bed exposed along the coast. A 20 kg portion of this sample, containing 50-60% garnets, was forwarded to the Canadian Centre for Mineral and Energy Technology (CANMET), Industrial Minerals Laboratory in Ottawa for testing the possibility of concentrating the garnet. The testing was

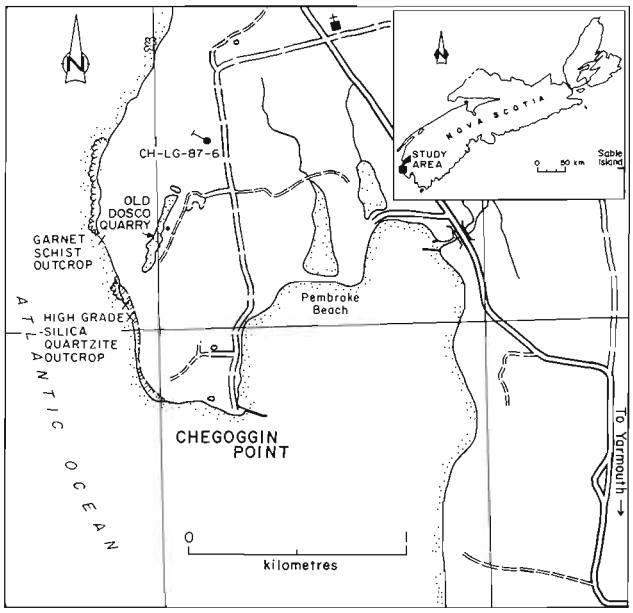

Figure 18. Location map showing high grade quartzite and garnet schist outcrops at Chegoggin Point, Yarmouth County. Drillhole CH-LG-87-6 completed during this program is shown northeastward along strike from the abandoned DOSCO silica brick Quarry.

successful. Gravity concentration, employing laboratory shaking tables, concentrated the garnet in the -840 +420 μm fraction to 70-75% garnet; in the -420 +150 μm fraction to 80-85% garnet; and in the -150 μm fraction to 95% garnet. Although garnet was effectively liberated in the -2.4 mm +840 μm fraction, concentration by tabling was not possible due to a combined effect of similarity in shape and specific gravity between garnet and chlorite, which was more critical at coarser sizes than finer sizes. Garnet in the -840 +420 μm fraction was further concentrated by reverse flotation of chlorite to 85% garnet. A complete report by Andrews (1988) is contained in Appendix 1.

This particular garnet-rich bed is exposed along the coast line and appears to be continuous inland to the shore of Island Pond, (Utley Lake, historical name) a distance of approximately 3 km (Fig. 19). The potential for similar garnet-rich beds is good in the adjacent rocks and in fact thinner beds have been intersected in diamond-drill holes targeted to test the high grade silica deposit to the south. DDH CH-LG-87-6 completed during this project intersected such garnet-rich beds (Fig. 18).

Very fine grained garnet occurs in the andalusite-rich mica schist at Doughboy Point, Guysborough County (Fig. 4). The garnets occur as clusters of small

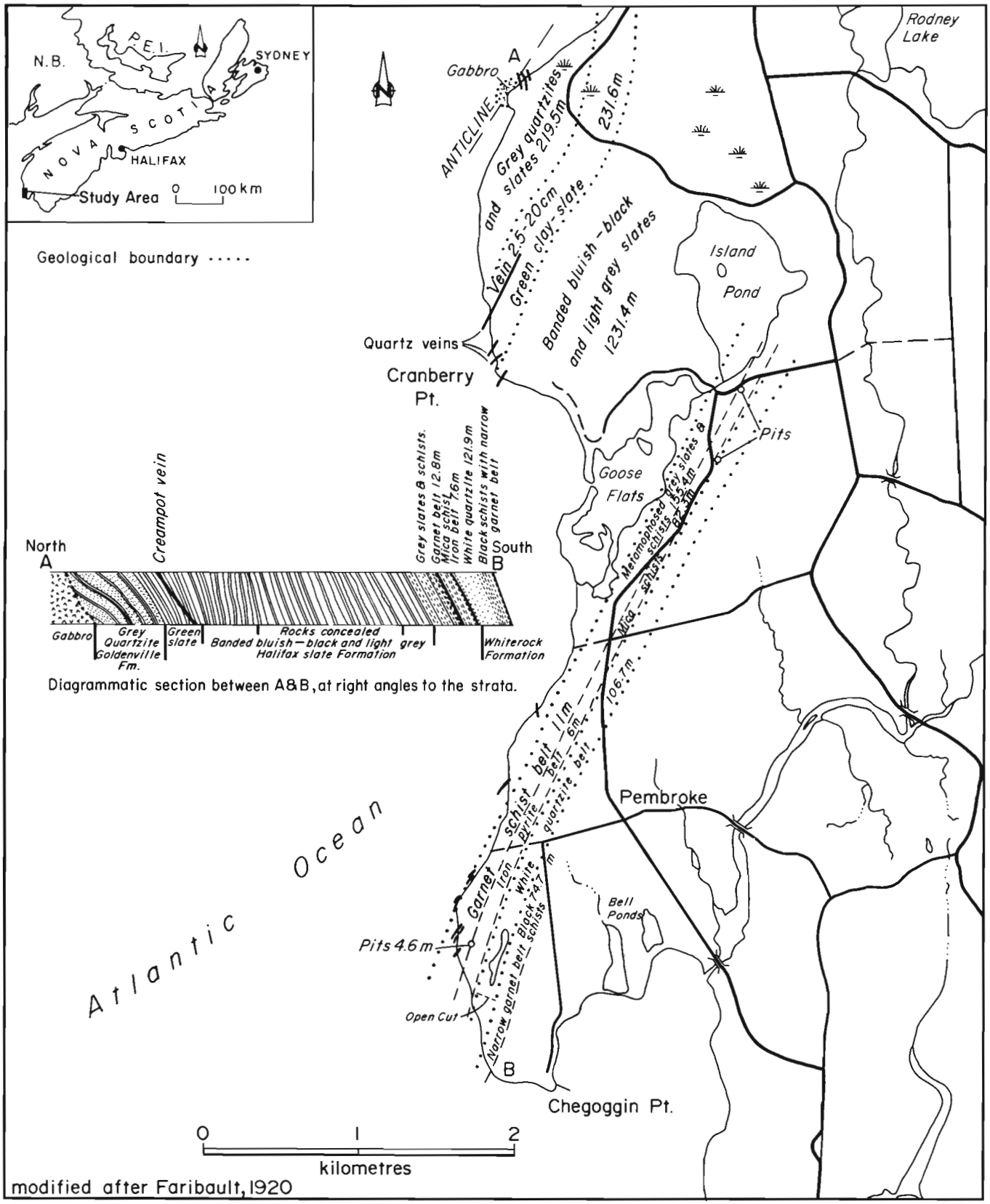

Figure 19. Geological plan and section showing the garnet zone at Chegoggin Point, Yarmouth County.

subhedral crystals about 0.02-0.05 mm in diameter. The clusters are about 0.2 mm across. The garnets are concentrated in thin bands cutting through the rock and are also distributed fairly uniformly throughout and appear to make up approximately 30% of the entire rock. The economic feasibility of mining this deposit for the garnet is dependent on what other commodities may be extracted as byproducts and the ease of separating the different minerals.

Other garnet occurrences with little apparent potential for economic development are located in Shelburne County at Negro Harbour, Round Bay, Port La Tour and in road cuts from Shelburne to Jordan Falls (Fig. 20). Large crystals of almandine garnets up to 30 mm in diameter have been found in rounded granodiorite boulders near Ten Mile Lake in the Liscomb Game Sanctuary, Halifax County, but to date no bedrock source has been located.

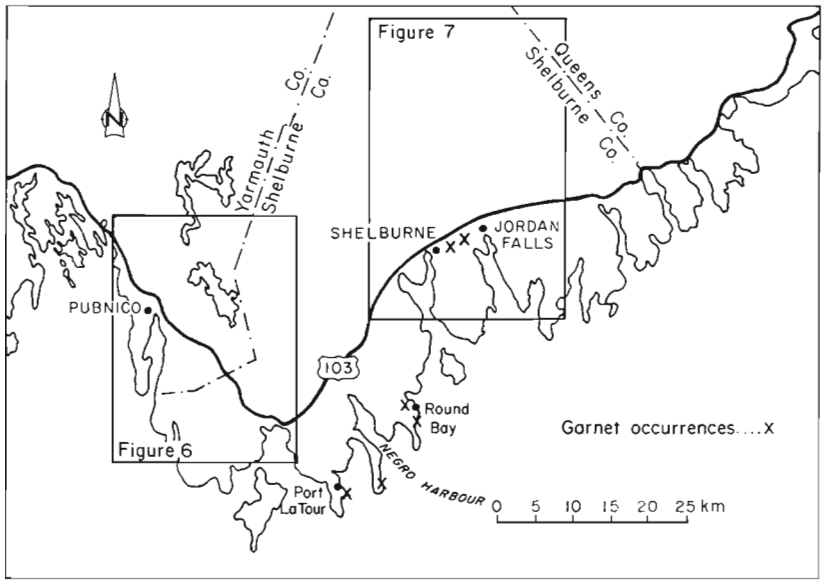

Figure 20. Location map showing garnet occurrences at Negro Harbour, Round Bay, Port La Tour and Highway 103 between Shelburne and Jordan Falls, Shelburne County.