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GRANULAR-AGGREGATE MAPPING IN SOUTHEAST LABRADOR

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ABSTRACT

In 2003, mapping and fieldwork for granular-aggregate deposits took place along the southeastern segment of the Trans-Labrador Highway (Route 510), as the initial phase of a two-year project to complete aggregate mapping along the recently constructed road. The first phase of mapping included the southern part of the road from Red Bay, NTS map area 12P/9, to the northwest end of NTS map area 13A/15, including the branch roads to St. Lewis (Route 513) and Charlottetown (Route 514).

Sand and gravel deposits were sampled near Black Bay, the St. Lewis Inlet, Hoop-Pole Brook, Alexis River and Gilbert Lake, and in the southwest corner of NTS map area 13A/15. These deposits vary from fine and medium sands to sandy gravel and gravel, and range in quantity from 40 000 m^3 to several million cubic metres of aggregate. Deposits at Black Bay, Hoop-Pole Brook and Port Hope Simpson are within a kilometre of the road, and close to communities for use in potential developments. Deposits close to roads and at greater distances from communities could be used in future road upgrading.

INTRODUCTION

The recently constructed gravel road (the southern segment of the Trans-Labrador Highway (Route 510) along the southeast coast of Labrador (Figure 1) between Red Bay and Cartwright, covers a distance of 325 km, and includes branch roads to St. Lewis (Route 513, 30 km) and Charlottetown (Route 514, 30 km) - Pensons Arm (Route 514, 25 km). The objectives of the aggregate-mapping program are to locate, map and sample, sand, gravel and till materials, in support of road upgrading and construction activities in nearby communities, and to reserve deposits for future development. Mapping aggregate deposits and providing data on their quality and quantity will help road builders, contractors and consultants determine sources and quality of material available in a given area, and evaluate distances to transport these materials to a specific job site, a factor that can greatly affect construction cost.

The demand for aggregate is closely associated with construction activity. Road construction and maintenance is by far the most important use of mineral aggregates. Aggregates are characterized by their high bulk and low unit value so that the economic value of a deposit is a function of its proximity to a market area as well as quality and size (Vanderveer, 1982). Comprehensive planning and resource-management strategies are required to make the best use of available resources, especially in areas experiencing rapid development. Such strategies must be based on a sound knowledge of the total mineral aggregate-resource base at both local and regional levels.

Definitions of aggregate depend on the producer, location and use of the material (Smith and Collis, 1993). Aggregate, as used in the context of this report, is defined as any hard, inert material such as gravel, sand, crushed stone or other mineral material that is used in the construction industry (Carter, 1981; Rutka, 1976). Aggregates are used extensively in all types of construction activities related to domestic, industrial or other developments. Road construction is a major consumer of aggregate material. Water and sewer systems, driveway construction and building foundations, backfill and topsoil, all require aggregate.

Aggregate materials can be, i) processed and used as Class A gravel (aggregate having a diameter of less than 19 mm and also having a specified proportion of finer grain sizes and 3 to 6 percent silt–clay; Department of Transportation, 1999) or Class B gravel (aggregate having a diameter less than 102 mm and, having a specified proportion of finer grain sizes and 3 to 6 percent silt–clay; Department of Transportation, 1999), ii) processed to mix with a cementing agent to form concrete, asphalt and mortar or iii) used as unprocessed, out of pit material.

Not all quarry materials are suitable as aggregate. Vanderveer (1983) defined the quality of mineral aggregate by its composition. The silt–clay quantity is important; high

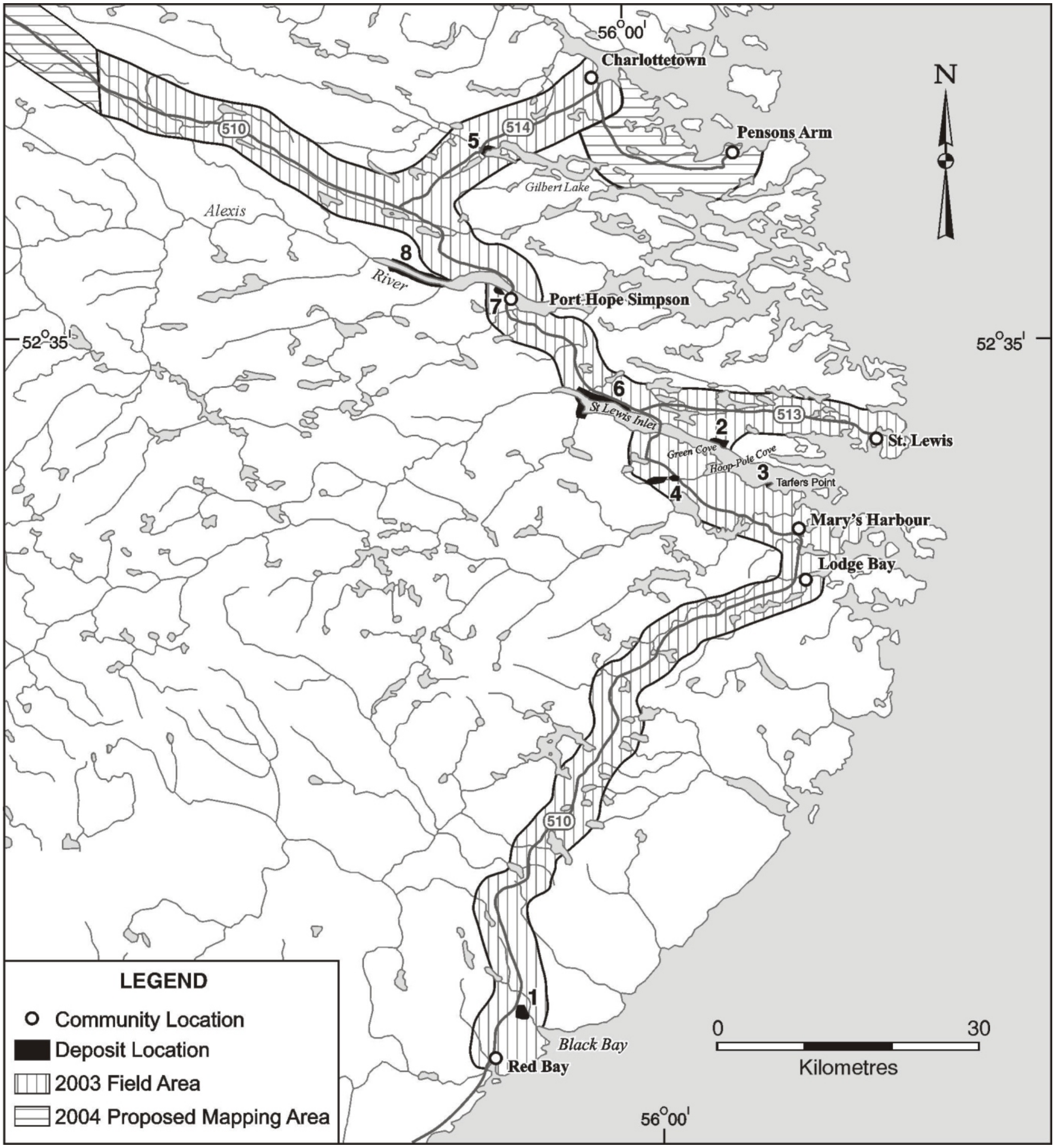

Figure 1. *Location map of the deposits examined in this survey.*

silt–clay can cause instability, such as flowage; low silt–clay can result in loss of compaction. Too much silt–clay in concrete (>2 percent) can interfere with the bonding process between the aggregate and the cementing agent. High silt–clay aggregate (greater than 15 percent) can be used for earth-filled dams, fill and subgrade road material. The presence of deleterious substances (such as silt–clay coatings or iron-oxide staining on the surface of the aggregate) or blade-shape fragments often cause bonding problems with the cementing agent or the breakdown of aggregate with time.

STUDY AREA

The study area is located on the southeast coast of Labrador between Red Bay (NTS map area 12P/9) and the southwest end of NTS map area 13A/15 (Figure 1). It consists of a 6-km-wide corridor following Route 510, along river systems near the highway, and in adjacent communities in coastal Labrador. The region's relief is moderate to low, and exhibits the well-weathered geomorphology, typical of glaciated terrains. The bays, although deeply incised, are shallow, and contain many rocks and islands. Field work was done by truck, by boat along the St. Lewis Inlet, the Alexis River and Gilbert River, and on foot to deposits within the 6-km-wide mapping corridor.

PREVIOUS WORK

The geographic outline of the region is discussed by Hare (1959), who completed a photo-reconnaissance survey of Labrador–Ungava primarily to determine vegetation type; drift cover and physiographic type were noted as a secondary objective.

Surficial geological mapping of the field area at 1:50 000 scale by Fulton *et al*. (1975), was based mostly on aerial photographic interpretation. This work was part of a much larger program, covering over 95 000 km^2 of southern and eastern Labrador. Compilation of these maps at 1:250 000 scale (Fulton *et al.*, 1979) and 1:500 000 scale (Fulton, 1986) show glacial-flow features having a dominant southeast to east orientation.

Aggregate-resource reconnaissance mapping (Ricketts, 1987) of parts of coastal Labrador concentrated on aggregate resources in the vicinity of community areas. This project resulted in the release of 1:50 000-scale landform classification maps and aggregate-resource maps for all coastal communities from Lodge Bay in the south, to Nain in the north. McCuaig (2002), who conducted a study of the Quaternary geology and glacial history in the Alexis River area and Blanc-Sablon to Mary's Harbour road corridor, identified the erosional effects of glaciation, and landform types resulting from glacial, glaciomarine and glaciofluvial deposition.

MAPPING AND ANALYTICAL METHODS

The economic assessment of granular aggregates can be difficult because of the great variety of source rocks, and also because the available information is commonly insufficient to determine quality of material, in local areas, for pit and quarry operations. Much interpretation is necessary and hence the degree of error in tonnage estimates can be high. Interpretation of aerial photographs (1:50 000 scale and 1:12 500 scale) is the first stage in locating potential deposits. Airphoto interpretation is used to produce preliminary landform classification maps that show the distribution and nature of the various deposits found within an area. They usually show a variety of tills, and sand and gravel deposits.

Till is a sediment deposited by a glacier, commonly having a wide variety of grain sizes. Sand and gravel are commonly formed by fluvial action, either by glacial meltwater or present-day streams. The landform classification is used as a guide to identify potential granular deposits that may be of use in the construction industry. Granular-aggregate maps are a derivative of landform classification maps, supplemented by ground proofing and sampling; they subdivide potential aggregate deposits into high, moderate or low potential.

The size of a deposit can be determined if its areal extent and average thickness are known or can be estimated. Thickness values are approximations, based on the face heights of pits developed in the deposit, road-side exposure or features of the general landscape such as the height of ridges and terraces above the surrounding terrain. Individual deposits are then assigned to one of four zones on the granular aggregate-resource maps, where Zone 1 is the area of highest potential (Kirby *et al*., 1983).

In addition to the data collected from aerial photographs, information on the various sediment types was obtained in the field by examining natural exposures (e.g., stream cuts, shorelines, and gullies) or man-made exposures (e.g., road cuts, and pit and quarry excavations). Where exposures were not available, samples were collected from 1-m-deep hand-dug pits. In some places, hand-dug pits were not practical because of the presence of boulders or a thick, cemented B-soil horizon, which made it difficult to see the undisturbed source material. Lack of exposures in such areas meant that deposit thickness was difficult to determine. The scarcity of vertical sections, combined with the presence of a concealing surface mat of organic material in many places, made positive interpretation of the nature and extent of the glacial sediment heavily dependent upon evaluation of the local geomorphology. Thus, in most instances, surface form was an important aspect in recognition of the unit mapped. Obvious landform boundaries on air photographs were the basis of many delineations. Other features recorded in the field were sediment thickness, stoniness, presence of compact layers and vegetation.

Sampling provided material for petrographic and grain-size analyzes, and at each site about 15 kg of material was collected for sieving. Field sieving and petrographic analysis were performed on samples containing >8-mm-size material. A split of the sand+silt+clay fraction (<8 mm) was retained for laboratory sieve analysis, which involved drying and splitting the sample to a manageable size (70 to 140 g), and wet and/or dry sieving of each sample following the procedures outlined in Ricketts (1987). This data was used to describe deposits based on texture. Cobble and boulder content (aggregate too coarse for sieving) was estimated in the field.

The suitability of aggregate depends on the physical properties and the capability of the rock to withstand stresses placed upon it when used as a construction material. The lithology of the pebble fraction (16 to 32 mm) was evaluated to define the petrographic characteristics (Bragg, 1995; Ontario Ministry of Transportation, 1994; Canadian Standards Association, 1973). The petrographic number can range from 100 to 1000; it is derived by taking the sum of the percentage of each rock type present in the pebble fraction (in a sample of approximately 100 pebbles) multiplied by a petrographic factor (based on soundness and durability) assigned to that rock type (Ricketts, 1996). The petrographic factor is determined mostly by rock type and grain size of the rock in a given sample, and also by the presence of silt–clay coatings, alteration, weathering, staining, degree of sphericity, rounding and fracturing. The lower the petrographic number, the better the quality of aggregate material. For example, a clean, hard, fresh gabbro would normally have a petrographic number of 100, whereas a friable, soft shale would be 1000. Most deposits contain a combination of different rock types having different petrographic factors. The proportion of each of these components determines the petrographic number. For most purposes, aggregate material used in concrete requires a petrographic number of 135 or less, whereas road asphalt and Class A and B gravels can tolerate aggregate having a petrographic number up to 150 (Department of Transportation, 1999). The roundness of pebbles, the number of fracture faces, and sphericity are important considerations in using an aggregate for concrete.

AGGREGATE POTENTIAL

South of Mary's Harbour, sample coverage was not extensive. In this area, glacial erosion has removed much of the surficial materials. The surficial geology consists mainly of exposed rock or a thin cover of glacial till, organics, and one glaciofluvial deposit (Black Bay). In areas north of Mary's Harbour, sampling was more extensive. Large deposits of glacial origin are common, and glaciofluvial and marine deposits of sand and gravel that have greater economic potential are more common (Figure 1, Table 1). These sand and gravel deposits are mostly small, with the most extensive deposits occurring at the mouths of the larger rivers, e.g., the St. Lewis Inlet area. Where the St. Lewis River reaches tidewater, extensive terraces composed of sand and a few pebbles and cobbles are found. Near Hoop-Pole Brook, along the St. Lewis Inlet, large sand deposits containing minor gravel are found sporadically, over a distance of 6 km. These deposits form a large ridge, possibly the result of erosional activity. Seven kilometres northwest of Mary's Harbour, on the north side of the St. Lewis Inlet is a delta, comprising bedded and crossbedded sands, pebbles, and boulders. The top of the delta is 40 m above sea level. Two to three kilometres northwest of Mary's Harbour, is a terrace deposit, 7 m above mean sea-level. A brief description of these deposits is given below.

BLACK BAY

The Black Bay glaciofluvial terrace deposit (1) is located 500 m east of Route 510 and 9 km north of Red Bay (Figure 1). A trail leads from the road to the deposit along the south side of Black Bay brook; the brook dissects the deposit in two. The surrounding region is rock and concealed rock under a burnt-over scrub forest.

The deposit contains about 100 000 m^3 of aggregate. Analyses of three samples collected from 1- to 1.4-m-deep, hand-dug pits (Plate 1) at the top of the terrace show an average of 70.2 percent gravel, 29.3 percent sand and 0.5 percent silt–clay (Table 1, Figure 2). The escarpment along the terrace edge is 5 to 8 m high and densely vegetated. Water seepage along the face of the lower slope of the north terrace indicates the presence of silt and clay. Excavating equipment is needed in these areas to determine grain-size characteristics at greater depths.

Plate 1. *Gravel from a hand-dug pit at the top of glaciofluvial terrace near Black Bay.*

Pebbles consist of fresh to moderately weathered gneiss (89 percent), fresh pegmatite (5 percent), fresh to highly weathered amphibolite (3 percent), fresh arkose (2 percent) and fresh volcanic rocks (1 percent). Petrographic numbers of samples are 126, 144 and 158.

Table 1. Summary results of sand and gravel deposits sampled along a 6-km-wide corridor along the Trans-Labrador Highway from Red Bay in the south, to Gilbert Lake in the north

Deposit	m^3	Gravel	Sand	Sl-Cl	No. of Samples Analyzed	PN Range	PN Average	Notes
Black Bay	100 000	70.2	29.3	0.5	3	126-158	143	Gravel and sand terrace
Green Cove	3 000 000							Gravel, sandy gravel and sand
Ridge		7.4	82.3	10.3	2	ND	ND	
Delta		59.9	39.9	0.2	2	123-158	140	
Tarfers Pt.	100 000	69.3	30.0	0.7	1	130	130	Gravel
Hoop-Pole Cove								Predominantly medium to fine
Sand Ridge	3 000 000	8.62	87.3	4.1	5	138	138	sand. Gravel along top of ridges
Gravel Ridge	200 000	69.6	30.0	0.4	7	136-191	155	
Gilbert Lake	10 000	1.9	94.8	3.3	3	ND	ND	Fine to medium sand
St. Lewis Inlet	>10 000 000	10	87.2	2.8	13	183-283	218	Fine to medium sand. Minor gravel in localized areas
Port Hope Simpson	30 000	15.7	76.5	7.8	2	163	163	Gravelly sand and sand. Variable silt-clay content
Alexis River	70 000	1.5	94.9	3.6	4	ND	ND	Fine to medium sand

Note: Estimated quantities in table are based on airphoto interpretation and observations at field sample locations. Grain-size percentages are based on a compilation of sample data for each deposit.

ND = not determined (due to the high proporation of sand in samples); Sl-Cl = silt-clay; PN=petrographic number

GREEN COVE

The Green Cove deposit (2) is located on the north side of the St. Lewis Inlet, 3.7 km south of the Fox Harbour road (Route 513) and 10 km northwest of Mary's Harbour (Figure 1). It contains an estimated 3 000 000 m^3 of aggregate. It is over 50 m high, has steep partly vegetated slopes, and exposed gravel. Medium to fine sand samples were collected from two shallow hand-dug pits along ridges at the top of the deposit. These samples consisted of 7.4 percent gravel, 82.3 percent sand and 10.3 percent silt–clay. Coarse sandy pebble gravel was collected from eroded exposures along the side of the deposit (Plate 2). Samples collected along these exposures consisted of 59.9 percent gravel, 39.9 percent sand and 0.2 percent silt–clay (Table 1, Figure 2). Pebbles consisted of fresh to highly weathered gneiss (71 percent) and fresh granite (29 percent). Petrographic numbers of the two samples are 123 and 158.

TARFERS POINT

The Tarfers Point deposit (3) is a marine terrace, located on the south side of the St. Lewis Inlet, 3 km northwest of Mary's Harbour, and 3.3 km north of Route 510 (Figure 1). It is about 350 m long, 100 m wide and 15 m high, and contains an estimated 100 000 m^3 of aggregate. Boulders are prominent along the top of the deposit. Sampling was difficult due to the high boulder concentration and a 1-m-thick iron- oxide layer. Boulders were less noticeable near the base of a 1.6-m-deep hand-dug pit at the top of the east-facing slope. Sampled material contains 69.3 percent gravel, 30 percent sand and 0.7 percent silt–clay (Table 1, Figure 2). Pebbles consisted of fresh to slightly weathered gneiss (52 percent), fresh to moderately weathered gneiss (28 percent), fresh pegmatite (16 percent) and highly weathered amphibolite (4 percent). The sample has a petrographic number of 130.

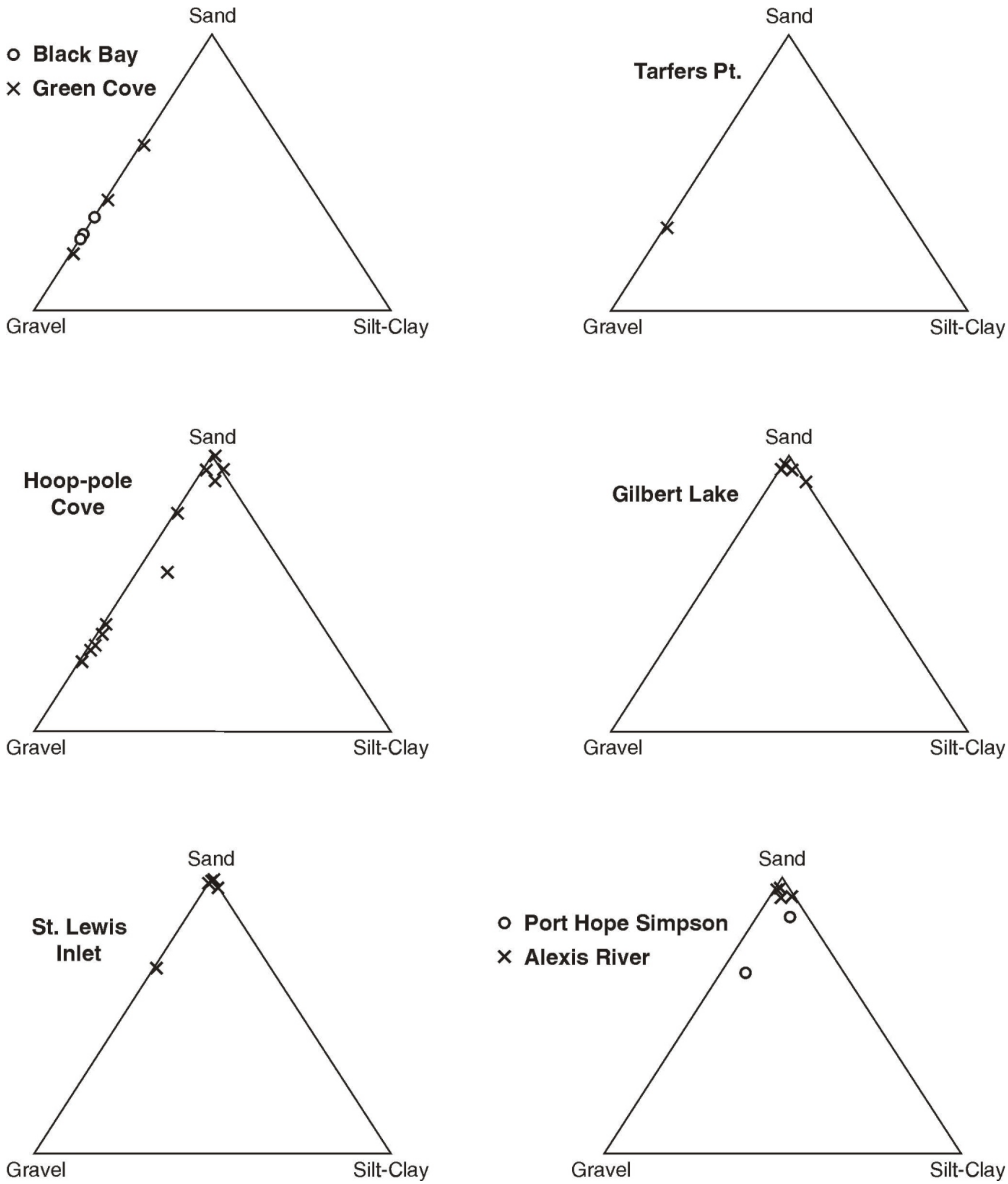

Figure 2. *Ternary plots of aggregate samples collected from deposits near Black Bay, Green Cove, Tarfers Pt., Hoop-Pole Cove, Gilbert Lake, St. Lewis Inlet, Port Hope Simpson and Alexis River.*

Plate 2. *Gravel and sand exposure along a 40-m-high delta located at Green Cove, on the north side of the St. Lewis Inlet, 3 km south of the St. Lewis access road.*

Plate 3. *Five-metre-high roadside exposure in the Hoop-Pole Cove deposit. Deposit content varies from gravel to fine sand and silt.*

HOOP-POLE COVE

The Hoop-Pole Cove deposit (4) is located southwest of the St. Lewis Inlet, east of Route 510 (Figure 1). This deposit consists of a large, predominantly sandy ridge over 2500 m long (locally overlain by a thin gravel unit about 1 m thick), and three smaller gravel ridges (Plate 3) ranging from 200 to 400 m long. The sand ridges are estimated to contain approximately 3 000 000 m^3 of aggregate comprising 8.62 percent gravel, 87.3 percent sand and 4.1 percent silt–clay. The gravel ridges contain about 200 000 m^3 of aggregate, with 69.6 percent gravel, 30.0 percent sand and 0.4 percent silt–clay (Table 1, Figure 2). Pebbles consist of fresh to moderately weathered granite (66 percent), fresh to moderately weathered gneiss (32 percent) and fresh volcanic rocks (2 percent). Petrographic numbers of 7 samples range from 136 to 191, with an average of 155.

GILBERT LAKE

The Gilbert Lake deposit (5) is a glaciomarine terrace deposit located on the southeast side of the Charlottetown access road, near the northwest end of Gilbert Lake and along Gilbert River (Figure 1). Three samples were collected from the 4- to 8-m-high lakeshore exposures, and two samples were collected from a 5-m-high quarry exposure. Predominantly medium-grained sand was sampled along the northeast side of the terrace in the lakeshore area, and medium to fine sand and silt–clays were sampled in the quarry area along the southwest side. The northeast side of the deposit, where the coarser sand units are located, covers an area of approximately 100 by 200 m and contains an estimated 100 000 m^3 of aggregate, consisting of 1.9 percent gravel, 94.8 percent sand and 3.3 percent silt–clay (Table 1, Figure 2). Samples collected on the southwest side of the deposit show 18 to 70 percent silt–clay. The deposit has low potential for coarse aggregates and moderate to high potential for medium to fine sand. Due to the fine-grained texture, samples were not analyzed for their petrographic quality.

ST. LEWIS INLET

The St. Lewis River deposit (6) is a flat-topped, partly eroded glaciomarine terrace (Plate 4), located near the mouth of the St. Lewis Inlet and 1 km southwest of the Trans-Labrador Highway (Figure 1). This deposit is over 8 km long and contains more than 10 000 000 m^3 of aggregate. The deposit is predominantly medium to fine sands, although coarse sand and gravel were collected in a few places. Locally, gravel may be as high as 47 percent, and silt–clay may be as high as 54 percent. Eighteen samples collected from 3- to 12-m-high shoreline exposures and have an average of 10 percent gravel, 87.2 percent sand and 2.8 percent silt–clay (Table 1, Figure 2).

Pebbles consist of fresh to intensely weathered micaceous gneiss (60 percent), fresh to moderately weathered

Plate 4. *Flat, medium to fine sand terrace (minor gravel) along the south side of the St. Lewis Inlet.*

granite (38 percent), and fresh granodiorite (2 percent). Petrographic numbers of samples analyzed are 183, 189 and 283.

PORT HOPE SIMPSON

The Port Hope Simpson deposit (7) is a marine terrace (Fulton *et al.*, 1975) located along the south side of the Alexis River, 1 km northwest of the community of Port Hope Simpson (Figure 1). Over half the deposit has been removed by past quarry activity. Remaining aggregate is estimated to be approximately 30 000 m^3. Two samples were collected from 3- and 12-m-high quarry exposures (Plate 5), showing stratified sand and minor gravel, to gravel–sand. Grain-size analyses show an average of 15.7 percent gravel, 76.5 percent sand and 7.8 percent silt–clay (Table 1, Figure 2). Pebbles consist of fresh to intensely weathered gneiss (74 percent), fresh granite (18 percent), fresh amphibolite (4 percent), quartz pebbles (3 percent) and fresh granodiorite (1 percent). A petrographic number of 163 was determined from analysis of one sample collected from this deposit.

Plate 5. *Fine to medium sand and gravel along 3- to 12-m-high quarry exposure near Port Hope Simpson.*

ALEXIS RIVER

The Alexis River deposit (8) is located 6 km west of Port Hope Simpson and 2 to 3 km southwest of Route 510 (Figure 1). The deposit is a sandy, eroded, glaciomarine terrace, over 10 km in length and not more than 3 m high. Samples collected from 3 river-cut exposures and one hand-dug pit indicate that this deposit is mostly a fine-grained sand, containing an average of 1.5 percent gravel, 94.9 percent sand and 3.9 percent silt–clay. The deposit contains an estimated 70 000 m^3 of aggregate. Quarrying of this deposit may be difficult because it is thin. Due to its fine-grained composition, samples were not analyzed for petrographic quality.

SUMMARY

Knowledge of the nature and distribution of the granular-aggregate deposits (sand, gravel and other low silt–clay materials) can assist in estimating the potential cost of construction projects requiring mineral aggregate. When it is necessary to site new pits for production of large quantities of construction material, close attention to the type of aggregate and the lithology of bedrock formation in the surrounding area should aid in making a choice. In a large-scale operation, it might be more economical to move pit products longer distances rather than use inferior material nearer at hand; processing costs could be lower and the quality of the product higher. Although sand and gravel aggregates are plentiful in Newfoundland and Labrador, they are fixed location, non-renewable resources.

Sand and gravel deposits were sampled at several locations along the St. Lewis Inlet, along Hoop-Pole Brook, Black Bay, the Alexis River and Gilbert Lake. These aggregate deposits vary from fine and medium sands to sandy gravel and gravel, and range in quantity from 40 000 m^3 to several million cubic metres. Deposits at Black Bay, Hoop-Pole Brook and Port Hope Simpson are within 1 km of the road, and are close to communities and could be used in road maintenance and in potential community developments. Deposits close to roads and at greater distances from communities could be used in future road upgrading.

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