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LAKE-SEDIMENT AND WATER-SAMPLING SURVEY IN THE ALEXIS RIVER REGION, SOUTHEASTERN LABRADOR

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ABSTRACT

A 2011 program of lake-sediment and water sampling in southeastern Labrador covered five complete and one partial NTS map areas, over which a total of 850 sites were sampled at a density of one sample per 6.1 km^2. Results for the analysis of 48 elements in sediment and 29 elements in water samples will be available later this year. The sampled area is underlain by rocks of the Interior Magmatic Belt and Exterior Thrust Belt of the southeastern Grenville Province. Over the past 15 years, the area has been the focus of exploration for magmatic Ni–Cu–Co–platinum-group metals, pegmatitic U and sapphire.

INTRODUCTION

This report summarizes a 2011 helicopter-supported lake-sediment and water-sampling program carried out over an area of approximately 5200 km^2 in the Alexis River area of southeastern Labrador (Figure 1). The sampling area covers NTS map areas 13A/02, 13A/07, 13A/08, 13A/10, 13A/14, and 13A/15, of which NTS map area 13A/14 was only partially (about 80%) sampled. The work is a continuation of a detailed lake-sampling program completed in 2006 and 2007 over the area to the north, south and east (McConnell and Ricketts, 2010).

Fieldwork was based in Mary's Harbour (52.303°N 55.848°W; NTS map area 3D/05); three fuel caches were set up: on the Trans-Labrador Highway between Mary's Harbour and Red Bay, at 51.904°N 56.410°W (NTS map area 12P/16); on the Trans-Labrador Highway northwest of Port Hope Simpson at 52.895°N 57.145°W (NTS map area 13A/14); and at the Port Hope Simpson airport (52.528°N 56.286°W; NTS map area 13A/09).

GEOLOGY AND MINERALIZATION

The sampled area is underlain by rocks of the Grenville Province (van Nostrand, 1992; Gower, 2010a, b, c). The southern portion (NTS map areas 13A/02 and the southern parts of 13A/07 and 13A/08) is underlain by the Interior Magmatic Belt, comprising:

a) Late Paleoproterozoic and early Mesoproterozoic (1800–1400 Ma) recrystallized granite and alkali-feldspar granite; syenite, alkali-feldspar syenite and quartz syenite and quartz monzonite,
b) Early Mesoproterozoic (1600–1400 Ma) syenite and quartz syenite; gabbro, norite and troctolite; monzonite and quartz monzonite, leucogabbronorite and anorthositic gabbro, amphibolite, and anorthosite to leucogabbronorite,
c) Syn-Grenvillian (*ca.* 1085–985 Ma) granite and alkali-feldspar granite; and
d) Early post-Grenvillian (*ca.* 985–975 Ma) syenite, quartz syenite and alkali-feldspar syenite

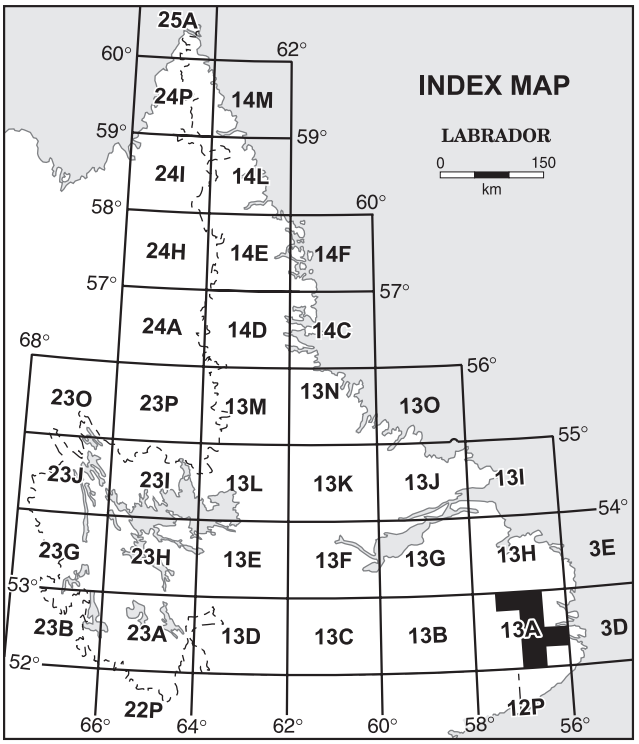

Figure 1. *Area of 2011 sample coverage.*

In the north (NTS map areas 13A/10, 13A/11, 13A/14 and 13A/15 and the northern parts of 13A/07 and 13A/08), rocks of the Exterior Thrust Belt comprise:

a) Late Paleoproterozoic (probably 1800–1770 Ma) pelitic and psammitic schist and gneiss,
b) Late Paleoproterozoic (1710–1660 Ma) granitoid augen gneiss, gneissic granodiorite, granite and alkali-feldspar granite; diorite to quartz diorite; anorthosite and leucogabbronorite; leuconorite and amphibolite,
c) Late Paleoproterozoic (1660–1600 Ma) gabbro and norite; amphibolite; granite to granodiorite; leuconorite and alkali-feldspar granite, granite and quartz monzonite, and
d) Minor late post-Grenvillian intrusions of granite to alkali-feldspar granite and syenite and quartz syenite

A general geological map is shown in Figure 2.

There are 43 documented mineral occurrences within the bounds of the sampled area, of which one has the status of prospect, and one the status of showing; the remainder are classed as indications. The former is the Rockhopper #8 sapphire prospect on NTS map area 13A/08, hosted in an intrusion of metasomatized anorthosite within a lens of pelitic gneiss (Unit P_{3A}sp, Gower *et al*., 1988; Gower, 2010b) approximately 12.5 km southeast of Port Hope Simpson. The latter is the Alexis River Tributary #4 U showing (Cole and Janes, 2008; Stapleton *et al*., 2011), hosted in pegmatite within psammitic schist and gneiss (P_{3A}ss, Gower, 2010a) in the northeast of NTS map area 13A/11. Of the 41 mineral indications, one is of Cu (the Bobbys Brook indication on NTS map area 13A/10, 13 km west of Port Hope Simpson), eleven of titanium (the Alexis River showings on NTS map area 13A/10, 48 km northwest of Port Hope Simpson), three of Fe, one of P, one of sapphire, one of garnet and two of mica; the remainder are of silica or pyrite.

Search Minerals Inc. and its subsidiary Alterra Resources Inc. have made eight new rare-earth element (REE) discoveries, as yet undocumented in the Mineral Deposits Database, in the area south and east of Port Hope Simpson (Search Minerals, Press Release, October 12, 2011).

SURFICIAL GEOLOGY AND ENVIRONMENT

Measured ice-flow directions are predominantly eastward; the five striation measurements within the sampled area range between 077° and 092° (Geological Survey of Newfoundland and Labrador, 2011).

Regional mapping of the surficial deposits (Klassen *et al*., 1992) indicates that the sampled area is mostly covered by undifferentiated till (although till is thin to absent at higher altitudes in the south), with glaciofluvial sediment in river valleys, ablation till in the northwest, and minor occurrences of glaciolacustrine sediment in the northeast. More detailed surficial mapping on NTS map areas 13A/10, 13A/14 and 13A/15 by McCuaig (2002a, b, c) indicates that till veneer is the most abundant cover type on all three map areas, especially 13A/15. Glaciofluvial material is the second most abundant type in NTS map areas 13A/14 and 13A/15, but is very scarce (about 1% of the map area) on 13A/10, where thick till and concealed and exposed bedrock occupy 55% of the total map area, collectively exceeding the area covered by till veneer (37%). Marine sediments are present in the southeast corner of NTS map area 13A/10, although they only occupy 1.2% of the total map area.

Elevations in the sampled area vary from less than 10 m asl near the mouth of the Alexis River (NTS map area 13A/10) to 485 m asl at 52.227°N 56.743°W in the north of 13A/02. Major watercourses comprise the eastward-flowing Alexis and St. Lewis rivers, and the north-flowing Hawke River.

PREVIOUS WORK – GOVERNMENT

Bedrock mapping has been completed in the sampled area by van Nostrand (1992), over NTS map area 13A/14, and Gower (2010a, b, c) over the entire area. A geological map of Labrador was compiled by Wardle *et al*. (1997).

Lakes in the area were sampled as part of the federal National Geochemical Reconnaissance (NGR) Program (Geological Survey of Canada, 1984). Presumably owing to the lack of large lakes, which was also noted during the current program, the average sample density was only one per 36 km^2 on NTS map areas 13A/02, 13A/10, 13A/14 and 13A/15, compared to the overall density in Labrador of one sample per 16 km^2 (which was achieved by the NGR program on NTS map areas 13A/07 and 13A/08).

The sediments were initially analyzed for Ag, As, Cd, Co, Cu, Fe, Mn, Mo, Ni, Pb, V and Zn using Atomic-Absorption Spectrophotometry (AAS) after *aqua-regia* digestion; F by Ion-Specific Electrode (ISE) analysis; Hg by cold-vapour-AAS; U by Neutron Activation/Delayed Neutron counting, and Loss-on-Ignition by gravimetry. The water samples were analyzed for fluoride by ISE, and for U by fluorimetry. The lake-sediment samples were subsequently recovered from the archives in the mid-1980s and analyzed by Instrumental Neutron-Activation Analysis

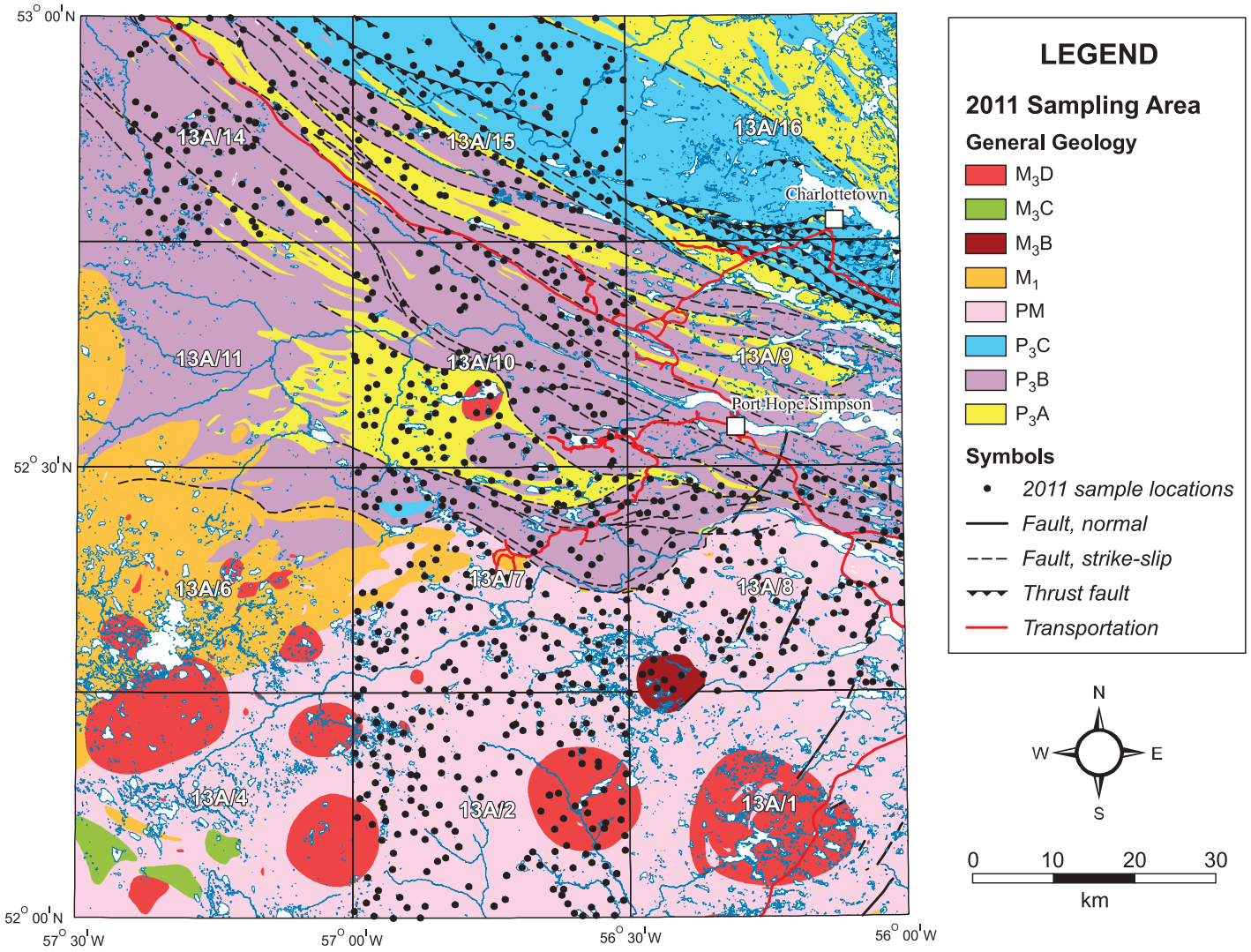

Figure 2. *General geological map of sampled area, with 2011 lake-sample locations.* ***P_3A:*** *Pre-Labradorian (probably 1800–1770 Ma) pelitic and psammitic schist and gneiss;* ***P_3B:*** *Early Labradorian (1710–1660 Ma) granitoid augen gneiss, gneissic granodiorite, granite, alkali-feldspar granite, diorite to quartz diorite, anorthosite, leucogabbronorite, leuconorite and amphibolite;* ***P_3C:*** *Late Labradorian (1660–1600 Ma) gabbro, norite, amphibolite, granite to granodiorite, leuconorite, alkali-feldspar granite, granite and quartz monzonite;* ***PM:*** *Late Paleoproterozoic and early Mesoproterozoic (1800–1350 Ma) recrystallized granite, alkali-feldspar granite, syenite, alkali-feldspar syenite, quartz syenite, and quartz monzonite (PMmq);* ***M_1:*** *Early Mesoproterozoic (1600–1350 Ma) syenite, quartz syenite, monzonite, quartz monzonite, gabbro, anorthositic gabbro, norite, leucogabbronorite, troctolite, amphibolite and anorthosite to leucogabbronorite;* ***M_3B:*** *Syn-Grenvillian (*ca. *1085–985 Ma) granite and alkali-feldspar granite;* ***M_3C:*** *Early Post-Grenvillian (*ca. *985–975 Ma) syenite, quartz syenite and alkali-feldspar syenite;* ***M_3D:*** *Late Post-Grenvillian (*ca. *975–955 Ma) granite to alkali-feldspar granite, syenite and quartz syenite.*

(INAA) for Au, Ba, Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Lu, Mo, Na, Ni, Rb, Sb, Sc, Sm, Ta, Tb, Th, U, W, Yb and Zn (Friske *et al*., 1994).

Results of the NGR program indicate three groupings of samples that are anomalous or elevated (that is, exceeding the 97.5 or 90-percentile of the regional dataset) in REE and Th, although somewhat diluted by background samples, within the sampled area; all are situated on ground currently (December 2011) staked by Search Minerals and its subsidiaries (*see* below). One concentration is centred about 15 km south-southeast of Port Hope Simpson; a second, situated south of the centre of NTS map area 13A/10, is also associated with elevated and anomalous values of U in sediment and water. The third is a concentration of mostly elevated (> regional 90-percentile) values of La, Ce and Sm, interspersed with background values, in the southeastern corner of 13A/07, to the east of a small granitic pluton of late Grenvillian age (Unit M_{3D}gr, Gower, 2010b) centred on 52.575°N 56.766°W. Element associations in till (*see* below) are also strongly suggestive of REE and rare metal (RM) enrichment in this area.

McCuaig (2002a, b, c) collected 367 till samples during the surficial mapping of NTS map areas 13A/10, 13A/14 and 13A/15. These were analyzed for Ag, As, Au, Ba, Br, Ca, Ce, Co, Cr, Cs, Eu, Fe, Hf, Hg, Ir, La, Lu, Mo, Na, Nd, Ni, Rb, Sb, Sc, Se, Sm, Sn, Sr, Ta, Tb, Th, U1, W1, Yb and Zn by INAA; Al, As, Ba, Be, Ca, Cd, Ce, Co, Cr, Cu, Dy, Fe, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, Sc, Sr, Ti, V, Y, Zn and Zr by ICP-OES after multi-acid ($HF-HNO_3-HClO_4$) digestion; Ag and Rb by AAS after HNO_3 digestion; and Pd and Pt by fire-assay ICP-MS. The granitic (Unit M_{3D}gr) pluton referred to above is the focus of the highest values in the till dataset of Be, Ta and most of the REE (mainly disposed to the west of the intrusion); Cs, K and Th (mainly disposed to the east) and Li, Mo, Rb and U (centred on the pluton and extending both east and west of it).

PREVIOUS AND CURRENT WORK – INDUSTRY

The study area has been the focus of past exploration for magmatic Ni–Cu–Co–platinum-group metal deposits (in the Kyfanan Lake layered mafic intrusion in NTS map area 13A/07, the Alexis River Anorthosite on 13A/08 and 13A/10, and the White Bear Arm Intrusive Complex on NTS map area 13A/15); for uranium in early Labradorian granites and gneisses on NTS map areas 13A/10 and 13A/14; and for sapphire in similar rocks on 13A/08. With the exception of the last named, none of this work resulted in any significant discoveries. The work is summarized in Table 1.

Table 1. Summary of work filed for assessment in sampled area

Company	Year	Assessment File No.	Relevant NTS Sheets	1	2	3	4	5	6	7	8	9	10
September Resources Ltd	1996	LAB/1195	13A/15		X					X	X		
Matrix Energy Incorporated	1996	013A/15/0033	13A/15	X		X		X					
Cartaway Resources Corporation	1996	LAB/1241	13A/07, 13A/08							X	X		
R. Andrews	1996	013A/08/0028	13A/08			X							
Greenshield Resources Inc.	1997	LAB/1205	13A/08, 13A/08	X		X							X
Greenshield Resources Inc.	1997	LAB/1222	13A/08, 13A/10							X	X		
Cartaway Resources Corporation	1997	013A/0034	13A/08			X							
Cartaway Resources Corporation	1997	013A/0036	13A/08										
J. Ralph and G. Hennessey	1997	013A/08/0032	13A/08			X							
Rockhopper Corporation	1997	LAB/1203	13A/08			X							
Cartaway Resources Corporation	1997	LAB/1240	13A/08			X							
Cartaway Resources Corporation	1998	013A/08/0043	13A/08	X		X			X				
Falconbridge Limited	1999	013A/0045	13A/15							X	X		
Tripple Uranium Resources Inc.	2007	013A/10/0060	13A/10			X	X						
Tripple Uranium Resources Inc.	2007	013A/0062	13A/10, 13A/14, 13A/15			X							
Tripple Uranium Resources Inc.	2008	013A/0067	13A/10, 13A/14							X		X	
Tripple Uranium Resources Inc.	2008	013A/15/0068	13A/15							X		X	
Tripple Uranium Resources Inc.	2008	013A/10/0069	13A/10							X		X	
Tripple Uranium Resources Inc.	2009	013A/0070	13A/10, 13A/14, 13A/15							X		X	

Note: 1 - Mapping; 2 - Conceptual Planning; 3 - Prospecting; 4 - Soil Geochemistry; 5 - Stream Geochemistry; 6 - Till Geochemistry; 7 - Aeromagnetics; 8 - Airborne EM; 9 - Airborne Radiometrics; 10 - Drilling

In 2011, Search Minerals Inc. and its subsidiary Alterra Resources Inc. were exploring for REE in the Port Hope Simpson area. Their ground holdings (in late 2011) consisted of 3704 claims totalling 926 km^2 in a belt 135 km long and 4–12 km wide, which overlapped the area of coverage of the current study in the northeastern one-third of NTS map area 13A/08 (including the companies' Foxtrot and High REE Island discoveries) and extended in a northwesterly direction through NTS map area 13A/10 and the northeastern corner of 13A/11 to the southern boundary of 13A/14. As of late 2011, the companies had filed no assessment work on these claims.

SAMPLE COLLECTION

Sampling was carried out from a float-equipped Bell 206-BL helicopter. A wooden platform was attached to the port side of the helicopter to facilitate sample retrieval but a winch was not used. Both sediment and water sampling followed procedures developed and described by McConnell (2009). Sample sites were selected by laying a 2 km grid over the area to be sampled and selecting one lake or pond within each cell for sampling. In general, smaller bodies of water were selected in preference to larger ones. In fact, over much of the sampled area the latter, and even the former, were absent; the median area of the sampled lakes, at 0.007 km^2, is much smaller than that for 2010 (0.03 km^2) or 2009 (0.1 km^2), and the overall sampling density of one sample per 6.1 km^2 falls short of the target density of one per 4 km^2. A total of 898 samples, including 48 site duplicates, were collected. Figure 2 shows the sample coverage and Table 2 summarizes the sampling statistics, with corresponding 2009 and 2010 figures for comparison.

Two duplicate sample sites were selected randomly from every sequence of 20 sample locations. The two duplicate sites were typically separated by a distance of 50 to 100 m. The following field parameters are recorded at each site: GPS waypoint number, sample depth, nature of vegetation surrounding the lake, sample colour, water colour, sample composition, potential sources of contamination and duplicate status. The NTS 1:50 000-map sheet number, lake area and lithological classification of the upstream drainage cell are also documented.

Lake-sediment samples were collected using a tubular steel sampler, fitted with a butterfly valve that opens on impact with the sediment and closes as the sample is retrieved. The sampler is designed so that once retrieved, it can be inverted and the contained sediment poured into a plastic container and thence into the sample bag. The rope used for retrieving the sampler is marked at 1 m intervals to estimate water depth at the point of sampling. Samples were stored in pre-numbered, water-resistant Kraft paper bags and air-dried at ambient temperatures for a few days before being shipped to the lab in plastic pails.

Table 2. Sampling statistics

	2011	2010	2009
Duration of program (days)	19	18	18
Days lost to bad weather	3.5	3.5	3
Total helicopter hours	98.5	98.1	108.5
Sites sampled	850	769	1,018
Field duplicate sites	44	42	51
Water-only sites	25	108	32
Minimum sampled lake depth (m)	0.05	0.3	0.2
Median sampled lake depth (m)	1.5	1.5	2.0
Maximum sampled lake depth (m)	22	15	14
Median lake area (km^2)	0.007	0.03	0.1

Water samples were collected in purified Nalgene bottles that were cleaned in the lab by leaching with acid and rinsing with distilled and de-ionized water. After collection, the sample bottles were refrigerated before being shipped in coolers.

SAMPLE PREPARATION AND ANALYSES

Sediment samples were dried at 40ºC, before being disaggregated using a mortar and pestle and screened through a 180 micron (80 mesh) stainless-steel sieve. Results from the analysis of the following parameters are expected during the first quarter of 2012:

- Ag, As, Au, Ba, Br, Ca, Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Lu, Mo, Na, Nd, Ni, Rb, Sb, Sc, Sm, Sr, Ta, Tb, Th, U, W, Yb, Zn and Zr by INAA
- Al, As, Ba, Be, Ca, Cd, Ce, Co, Cr, Cu, Dy, Fe, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, Sc, Sr, Ti, V, Y, Zn and Zr by ICP-OES after 'total' (HF-$HClO_4$-HNO_3) digestion
- Ag by AAS after HNO_3 digestion
- F by Fluoride-ion Specific Electrode after Na_2CO_3/KNO_3 fusion
- Loss-on-ignition in muffle furnace (500º C), by gravimetric methods

With the exception of pH, conductivity and fluoride ion, all water analyses take place after 0.45 micron millipore filtration and HNO_3 acidification. The water samples will be analyzed for the following parameters:

- pH by Corning combination pH electrode
- Conductivity by Corning conductivity sensor
- F by Fluoride-ion Specific Electrode
- Ca, Fe, K, Mg, Mn, Na, Si, SO_4 by ICP-OES
- Al, Ba, Be, Co, Cr, Cu, Li, Mo, Ni, P, Pb, Sr, Ti, V, Y, Zn by ICP-OES/ultrasonic nebulizer
- U by ICP-MS

SUMMARY OF FIELD SAMPLING DATA

The areal distribution and relative frequencies of sample depths, sample colours, sediment textural types and shoreline vegetation types are summarized in Figures 3–6.

Only 64% of the samples were collected at water depths of 2 m or less (Figure 3), compared to 72% in the Fraser Lake region (western Labrador) in 2010 and 75% in the Knox Lake region (western Labrador) in 2009. Furthermore, 10% of the samples were collected at water depths exceeding 8 m, compared to only 1% at Fraser Lake. However, the median water depth, at 1.5 m, while the same as that for 2010, was less than that for 2009 (2.0 m). The deepest sample was recovered at a water depth of 22 m southwest of the centre of NTS map area 13A/10.

Sampled sediments were mostly (75%) reported as brown or chocolate brown (Figure 4) and these two types occur together over most of the sample area. Exceptions include concentrations of grey and grey-brown samples in the northeast of NTS map area 13A/02, and of greenish brown samples in the west of 13A/10.

Samples consisting of organic ooze, organic granular and organic peaty material each make up about 30% of the total (Figure 5). The first of these types predominates in the southern half of NTS map area 13A/10, southeastern 13A/07 and northeastern 13A/02, and most of 13A/08; the latter two are predominant over most of 13A/15 in the north, and 13A/02 in the south, although there are concentrations of clastic samples (fine and coarse grained) in the northwest and southeast of the last map area.

Forest, and mixed forest and swamp, collectively account for more than 50% of the sampled lakes' shoreline vegetation types (Figure 6). Of the other types, there are conspicuous concentrations of rock and forest in the area straddling the northwest of NTS map area 13A/07, the west and southwest of 13A/10, and the area straddling the southeast of 13A/07 and northeast of 13A/02. Swamp vegetation is concentrated in the northwestern two-thirds of NTS map areas 13A/02, and most of 13A/15.

SUMMARY

The detailed sampling of lake sediments and waters in southeastern Labrador was continued in the summer of 2011 with a helicopter-supported lake-sampling program centred on the lower Alexis River. The area of coverage is the current focus of exploration for REE, with the recent announcement of eight new discoveries. A total of 850 sites were sampled over a three-week period, at an overall density of one per 6.1 km^2. Sampled lake depths ranged from 0.05 to 22 m and the median area of the lakes sampled was 0.007 km^2.

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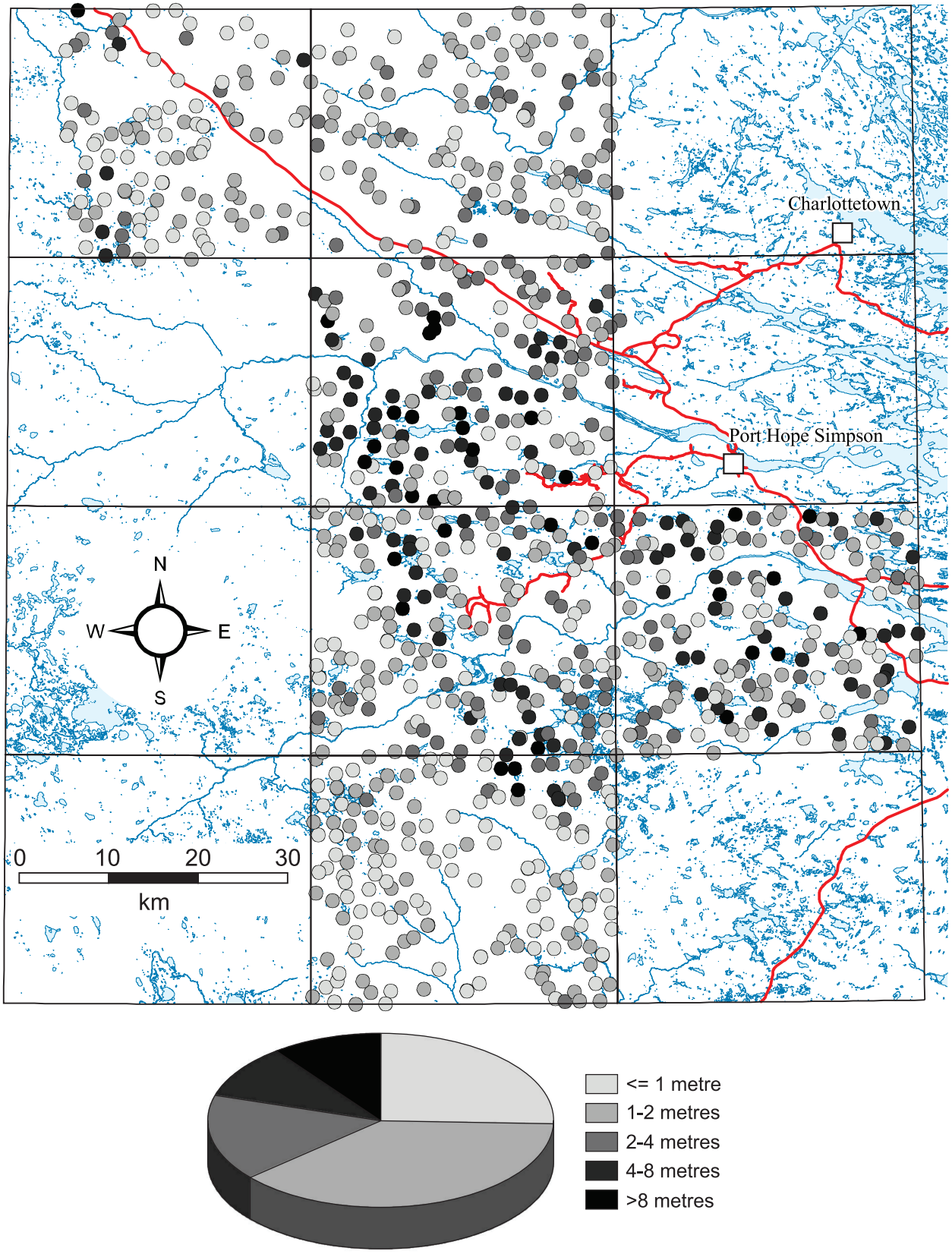

Figure 3. *Areal distribution of lake depths at sample locations and pie-chart showing frequency of sample depth classes in sampled lakes.*

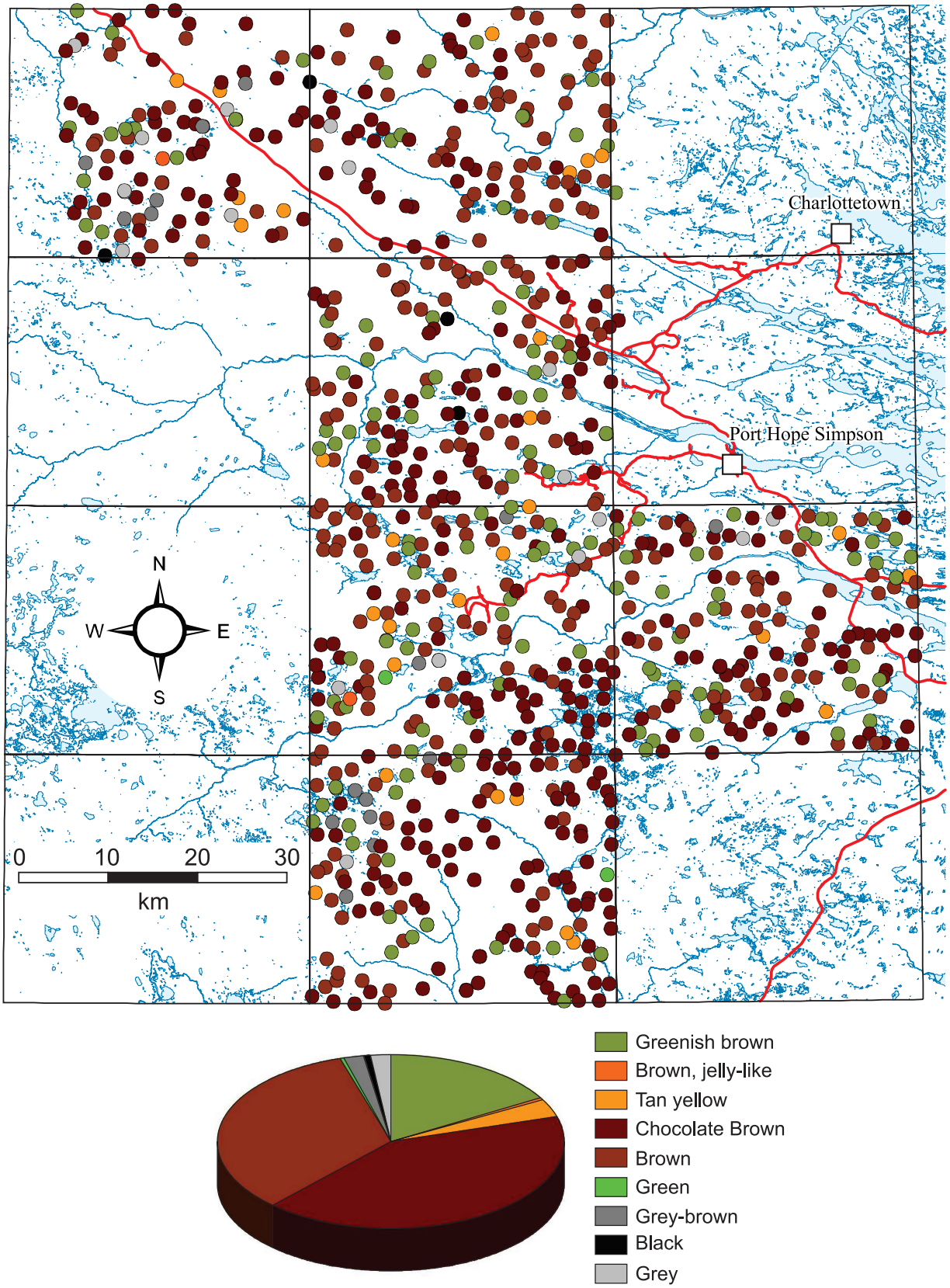

Figure 4. *Areal distribution of sediment colours at sample locations and pie-chart showing frequency of sediment colours sampled.*

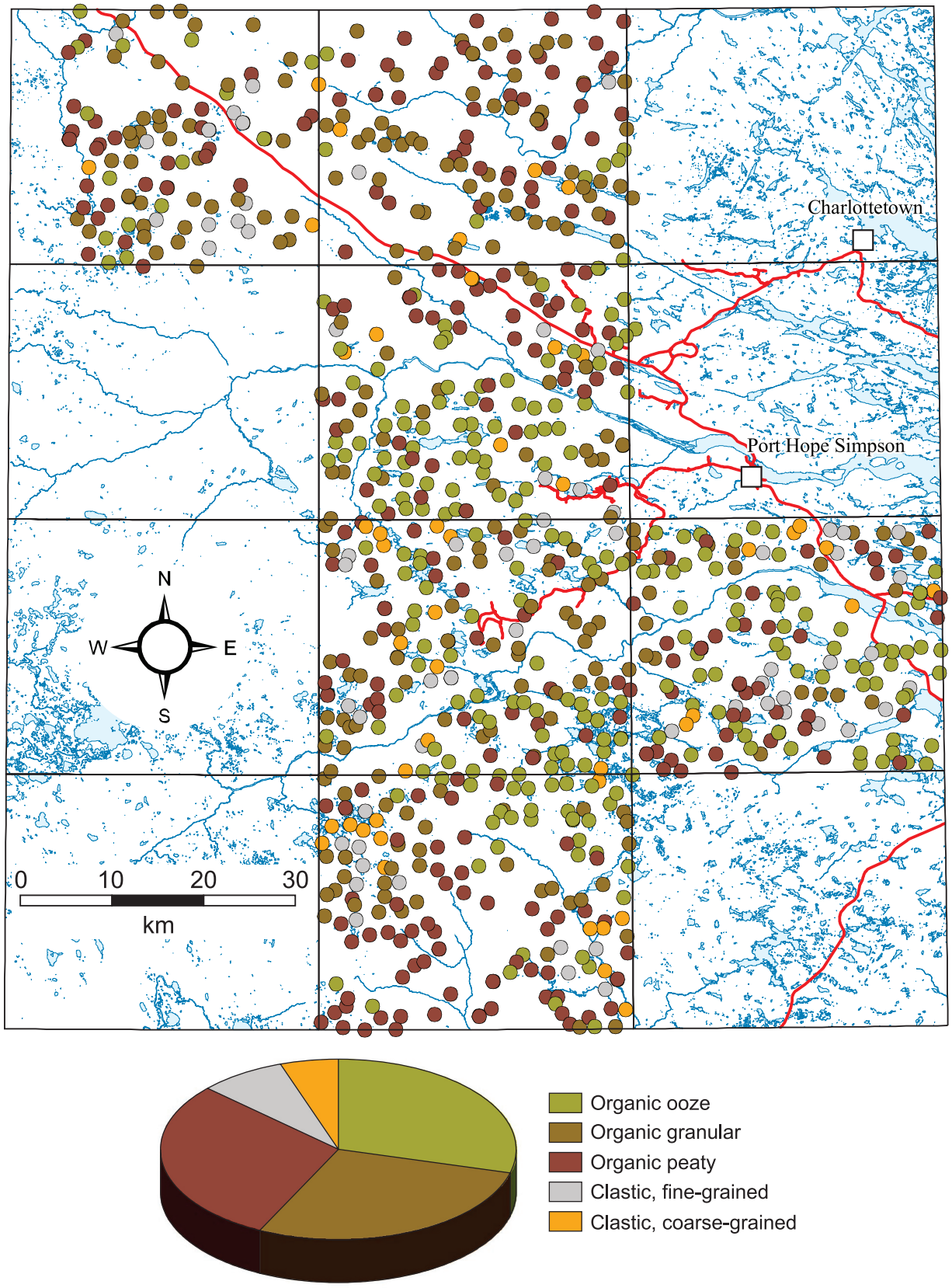

Figure 5. *Areal distribution of sediment textures at sample locations and pie-chart showing frequency of sediment textures sampled.*

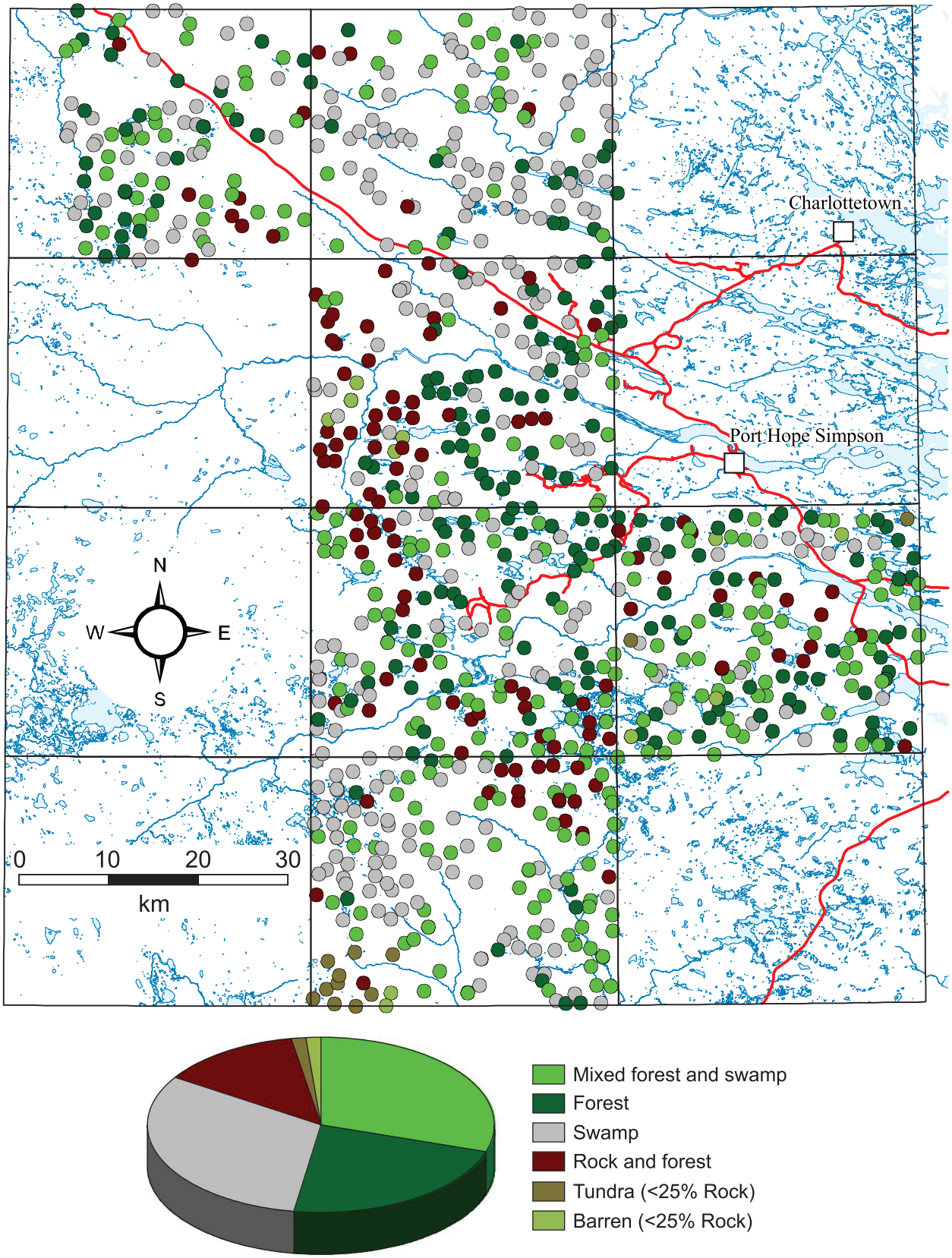

Figure 6. *Areal distribution of vegetation types at sample locations and pie-chart showing frequency of vegetation types surrounding sampled lakes.*

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