Current Research (2011) Newfoundland and Labrador Department of Natural Resources
Geological Survey, Report 11-1, pages 43-67

HIGHLIGHTS OF A HIGH-DENSITY LAKE-SEDIMENT AND WATER SURVEY IN SOUTHEASTERN LABRADOR

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ABSTRACT

*A lake-sediment and water survey was conducted in 2006 and 2007 over parts of NTS map areas 2M, 3D, 12P, 13A and 13H in southeast Labrador. The surveyed area is underlain primarily by rocks of the Grenville Province, which in this area, is subdivided into a northern exterior thrust belt and a southern interior magmatic belt. The Grenvillian thrust belt is composed predominantly of crust formed during the Labradorian Orogeny (*ca. *1710 to 1620 Ma). The interior magmatic belt is characterized by numerous Grenvillian (*ca. *1080 to 960 Ma) plutons emplaced into an assemblage of 1510 to 1450 Ma granitic intrusions that were themselves intruded into Labradorian crust.*

A nominal sampling density of one sample per 4 km^2 was used, although the lack of suitable lakes in some areas reduced the local sample density. Sampling was conducted by float-equipped helicopter using a weighted tubular steel gravity sampler for sediment collection. Lake-sediment samples were collected and analyzed from 2129 sites, and water samples from 2234 sites. In addition, one site in twenty was sampled in duplicate for quality control purposes. Sediment samples were analyzed for a standard suite of 48 elements and loss-on-ignition. In a few cases, a scarcity of material prevented analysis of the full analytical suite. Additionally, 13 of the elements were analyzed by two methods. Waters were analyzed for pH, conductivity and 27 elements.

There are many areas demarcated by samples having anomalous contents of various ore elements. Several clusters of samples have elevated contents of copper, nickel and zinc. Many of the clusters are over rock units that are elsewhere known to be mineralized in these elements. Several sediment and water samples with high uranium values are in granitic terrane. One anomalous cluster in NTS map area 2P/16 is coincident with a uranium mineral occurrence. Several areas in the southern part of the survey, also in granitic terrane, are distinguished by samples having high levels of rare-earth elements. These elements include cerium, dysprosium, europium, lanthanum, terbium, yttrium and ytterbium. Other elements that warrant interest include niobium, tantalum and gold.

INTRODUCTION

This paper presents and interprets some of the highlights of an open-file report by McConnell and Ricketts (2010).

The survey field work was conducted during the summers of 2006 and 2007. During 2006, the southern portion of the area was sampled. Work was conducted from the town of Mary's Harbour. The northern portion was sampled in 2007 working from Cartwright and Charlottetown. Road access provided an easy method of putting out small fuel caches for the float-equipped helicopter.

The area was selected for detailed-scale surveying for several reasons. First, several types of mineralization were already known to occur in the area including base metals, thorium, uranium and zirconium. Results from earlier reconnaissance-scale surveys indicated above-average levels of these elements (Friske *et al.*, 1994a, b). Discussions with Dr. Charles Gower of the Geological Survey regarding his several years of field work and bedrock mapping in the area gave further encouragement. Finally, a new highway network extending from north to south, and most recently to the west, will provide industry with the necessary infrastructure to facilitate exploration.

LOCATION, ACCESS AND PHYSIOGRAPHY

The survey area is located in southeastern Labrador (Figure 1). Most of the survey area is accessible by roads. A

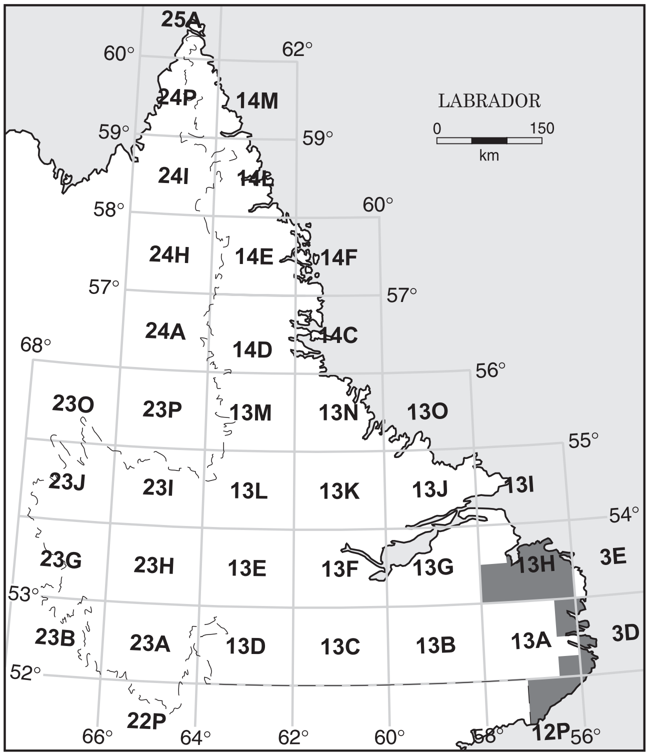

Figure 1. *Location of survey area.*

highway runs from the Québec–Labrador border in the south, to Cartwright in the north with several branch roads serving coastal towns. The south Labrador coast is accessible by vehicle, and by seasonal ferry service from the Island of Newfoundland that runs between St. Barbe and Blanc Sablon. Roads in the area now also connect to Happy Valley-Goose Bay and the Canadian road network. Most of the relief is moderately rugged and the landscape is covered by trees or wetlands except within a 20-km-wide coastal fringe that is dominantly bedrock.

PREVIOUS GEOCHEMICAL SURVEYS

The area was included in the Labrador reconnaissance-scale lake-sediment surveys that had an average density of one sample per 14 km^2 (Friske *et al.*, 1994a, b). Sediment analyses included 39 to 43 elements, as well as U, F and pH analyses of water. Additionally, a regional-till survey was completed immediately to the west of this lake survey in NTS map areas 13A/10, 14 and 15 (McCuaig, 2002).

The median and maximum values in the reconnaissance-scale and detailed-scale surveys of the rare-earth elements (REE) Ce, Dy, Eu, La, Sm, Tb and including the transition metal Y, U and the chalcophile elements Cu, Mo and Ni are provided in Table 1. Except for Yb, all the maximum REE values in the detailed survey exceed the maximum values in the regional survey, sometime by two-fold. In the case of U, the maximum value in the detailed survey is more than 5 times that found in the reconnaissance survey. For the chalcophile elements all maximum values in the detailed survey exceed those of the reconnaissance survey although by lesser magnitudes than are found in most of the previous elements.

GEOLOGY AND MINERALIZATION

The surveyed area is underlain primarily by rocks of the Grenville Province. The geology and following descriptions are derived from the 1:1 000 000-scale geological map of Labrador (Wardle *et al.*, 1997) and the 1:100 000-scale mapping of Gower (2005). The Grenville Province is subdivided into a northern exterior thrust belt and a southern interior magmatic belt. In the survey area, the boundary between the two extends approximately west-northwest from Mary's Harbour.

The exterior thrust belt is a Grenvillian tectonic feature but composed predominantly of crust formed during the Labradorian Orogeny (*ca.* 1710 to 1620 Ma). The belt is divided into four thrust-bound terranes in the survey area. Three of these, the Groswater Bay, the Hawke River and the Lake Melville terranes, are composed of mixed assemblages of calc-alkalic tonalitic–granodioritic gneiss, mafic and granitoid intrusions and metasedimentary gneiss. The fourth, the Mealy Mountains terrane, includes a weakly deformed anorthosite–monzonite–charnokite–granite (AMCG) suite and pre-Labradorian and Labradorian gneissic and granitoid crust.

The interior magmatic belt is characterized by abundant Grenvillian (*ca.* 1080 to 960 Ma) magmatism and consists of rocks of the Pinware terrane in the survey area. Plutons were emplaced into an assemblage of quartzofeldspathic gneiss and granitic intrusions during Pinwarian orogenesis (1520–1460 Ma) that were themselves intruded into Labradorian crust.

Three types of base-metal mineralization occur in the survey area − nickel, copper and molybdenum (Mineral Occurrence Data System (MODS), 2009). Seven occurrences of Ni, classified as 'indications' are known from mafic rocks in the Hawke River terrane (*see* Figures 5 to 14). Twenty-nine examples of Cu mineralization are listed in the survey area. Of these, one is classified as a 'showing' and the remainder as 'indications'. Two Mo occurrences are known. One is located about 11 km east of Cartwright and the other is in NTS map area 12P/16, about 30 km northeast of Red Bay. One hundred and thirteen Py occurrences are identified. Of these, 10 occur in the interior magmatic belt, and 103 are found in the exterior thrust belt. Many of the Cu and Py occurrences are found near or on the coast where

Table 1. Median and maximum values (ppm) in lake sediment in reconnaissance and detailed surveys

	Reconnaissance Survey		Detailed Survey	
REE elements	**Median**	**Maximum**	**Median**	**Maximum**
Ce1	80	841	55	982
Dy2	3.8	41	2.9	86
Eu1	1	13	1	24
La1	37	649	28	675
Sm1	6.1	87.4	4.1	170
Tb1	0.07	8.7	<0.5	16
Y2	21	296	16	387
Yb1	2	32	2	22
U1	1.5	90	2	469
Chalcophile elements				
Cu2	16	146	12	181
Mo1	<0.5	90	<0.5	117
Ni2	11	80	9	89

exposure is best, suggesting that many undetected mineral occurrences may occur in the same rocks farther inland.

The most recent MODS data records two uranium occurrences (indications) within the survey area, both located in NTS map area 12P/16. In addition, there is a Th–U showing, located in NTS map area13H/02.

There is one instance of zirconium mineralization, the Fox Harbour occurrence, located in NTS map area 3D/05. This is of interest as it may be associated with rare-earth mineralization.

Just as this paper was submitted to the publication process, an important report on mineral occurrences and metallogenesis in eastern Labrador was released (Gower, 2010). The author describes new occurrences not recorded in the MODS database at the time of writing but will be available later this year. Readers are encouraged to refer to this to get the most current information on mineralization in southeastern Labrador.

SURFICIAL GEOLOGY

The most recent surficial geology map that covers the survey area is at the 1:1 000 000 scale (Klassen *et al.,* 1992). The northern part (NTS map areas 13H, 3E/5, 12 and 13) was mapped at 1:50 000 (Fulton and Hodgson, 1974). Klassen *et al*. (*op. cit.*) indicates that most of the inland area is covered by undifferentiated till. In contrast, much of the coastal area, extending generally from 2 to 20 km inland, features thin till or exposed bedrock. Of secondary importance are glaciofluvial deposits found generally along some of the modern drainages and a few occurrences of glaciomarine and marine deposits found near the coast. There are also a few minor occurrences of hummocky till indicating areas of ice stagnation.

The mapping by Fulton and Hodgson (1974), consisting of airphoto interpretation with limited ground checking, provides a few striae that offer clues to ice-movement directions in the northern portion of the survey area. In the area to the west, southwest and south of Sandwich Bay (NTS map areas 13H/5, 6, 11 and 12), the ice-flow indicators are predominantly oriented to the northeast and a few to the east. In the south, toward the coast, Klassen's (Klassen *et al.,* 1992) mapping of drumlins and flutes suggests a predominantly southeastward flow. Marine limits in the area are 150 m above the present shoreline at Red Bay and 100 m at Cartwright.

SAMPLE COLLECTION

The collection procedure involves landing a float-equipped 206-B Jet Ranger helicopter on the lake surface and dropping a weighted tubular sampler fitted with a nylon rope for retrieval. A butterfly valve in the bottom of the tube opens upon impact with the sediment and closes upon retrieval, trapping the contained sediment. Samples are stored in water-resistant Kraft paper bags. Markings on the rope permit determination of the sample depth. Other observations made during sampling include GPS coordinates of the site, the nature of vegetation surrounding the lake, sediment colour, texture, composition and water colour.

Samples of organic lake sediment were collected from 2129 sites and water samples were obtained from 2234 sites. Additionally, approximately one site in 20 was sampled in

Table 2. Analytical methods for lake-sediment samples

ELEMENTS and LOI	METHOD	DIGESTION/PREPARATION
As, Au, Ba, Br, (Ca), Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Lu, Mo, Na, Nd, (Rb), Sb, Sc, Sm, Ta, Tb, Th, U, W, Yb, (Zr)	Instrumental Neutron Activation Analysis (INAA)	5 to 10 g in shrink-wrapped nial (total analysis)
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, Zr*	Inductively Coupled Plasma Emission Spectrometry (ICP-ES)[1]	$HF-HClO_4-HCl$ (total digestion)
Ag	Atomic Absorption Spectrometry (AA)[2]	HNO_3
F	Fluoride-ion specific electrode with digital ion analyser	2:1 Na_2CO_3:KNO_3 flux, fusion
Loss-on-ignition (LOI)	Gravimetric using muffle furnace raised to 500°C	

* Indicates preferable method of analysis.
Brackets enclosing element name "( )" indicate less favoured method of analysis; use alternative.

[1] Finch (1998)
[2] Wagenbauer *et al.* (1983)

duplicate. These duplicate samples were collected about 50 m apart. Generally, smaller lakes were sampled in this survey to obtain a more detailed geochemical perspective than was the case for the reconnaissance survey. Normally, the centre of the lake was sampled or, if apparent from the air, the central basinal portion of the lake. On some deep lakes (*i.e.,* with a centre depth greater than 25 m), samples could not be retrieved, and, a shallower site, closer to shore, was sampled.

Samples of lake water were collected before the sediment sampler was dropped to avoid water contamination. Samples were collected in purified, 125 mL Nalgene bottles. These were filled by immersing the bottles about 40 cm below the lake surface. Prior to sampling, the bottles were acid leached in the laboratory, and washed with distilled and deionized water. Sampling of a typical site took about one minute between helicopter touchdown and takeoff.

SAMPLE PREPARATION AND ANALYSES

Preparation

Lake sediments were partially air-dried in the field prior to shipping to the Geological Survey's laboratory in St. John's for final oven-drying at 40°C. The samples were then disaggregated using a mortar and pestle before being screened through a 180 micron stainless-steel sieve. The fine fraction was retained for chemical analyses. To monitor analytical precision, five percent of the samples were randomly selected, split and included as blind duplicates in all analytical procedures. Water samples were stored in a cool environment prior to shipping to St. John's. At the laboratory, the water samples were filtered using a 0.45 µm millipore filtration apparatus.

Analyses

The lake-sediment samples were analyzed for 48 elements plus loss-on-ignition. In addition, the samples were analyzed for 13 of these elements using a second method for a total of 62 separate determinations. Elements that are analyzed using two methods, one of which gives preferable results for reasons of improved detection limit or precision, are distinguished by an asterisk in Table 2. All analyses except INAA were performed in the Geological Survey's laboratory. The INAA analyses for samples collected in 2006 were performed by Becquerel Laboratories and for samples collected in 2007, by ActLabs. Results from these two labs are not strictly comparable and this issue is discussed below under *Data Quality*. To enable the user to readily distinguish the method of analysis for a given element, a suffix is attached to the element symbol when used in most tables and figures. The key to the suffixes is given in Table 2.

Lake water was analyzed for conductivity, pH, SO_4 and 26 elements using the methods noted in Table 3. Uranium in water was analyzed by SGS Lakefield Research Limited using ICP-mass spectrometry. All other analyses were per-

Table 3. Analytical methods for lake-water samples

ANALYSIS	METHOD	METHOD SUFFIX	PREPARATION
pH	Combination pH electrode		None
Conductivity	Conductivity sensor		None
Ca, Fe, K, Mg, Mn, Na, Si, SO_4	ICP-emission spectroscopy[1]	1	Filtration (0.45µm) and HNO_3 acidification
Al, Ba, Be, Co, Cr, Cu, Li, Mo, Ni, P, Pb, Sr, Ti, V, Y, Zn	ICP-ultrasonic nebulizer[1]	2	Filtration (0.45 µm) and HNO_3 acidification
As	ICP-ultrasonic nebulizer[1]	2x	Filtration (0.45 µm) and HNO_3 acidification; H-H_2O_2
F	Fluoride-ion specific electrode with digital ion analyser	9	Filtration (0.45 µm)
U	ICP-mass spectrometry	3	Filtration (0.45 µm) and HNO_3 acidification

[1] Finch (1998)

formed by the Geological Survey laboratory. The key to the suffixes is given in Table 3.

DATA QUALITY

To ensure the reliability of the analytical data, three methods of determining data accuracy and precision were employed. First, during sample collection, one site in 20 was sampled in duplicate. The duplicate samples were taken about 50 m apart. Eighty-six sites were sampled for sediment and water duplicates. Analyses of these site duplicates give an appreciation of within-lake data variation. Second, at the analytical stage, a standard of known composition was inserted within every batch of 20 samples. For sediment, international reference standards composed of lake-sediment material were used, notably LKSD-1, LKSD-2, LKSD-3 and LKSD-4. For water, standards used were both naturally occurring water and synthetic standards created in the laboratory to predetermined compositions. The results of these standards were monitored to ensure analytical accuracy and precision. Third, a sample split (*i.e.*, laboratory duplicate) was included in every batch of 20 samples. These duplicates were compared to ensure adequate precision.

Site duplicates are useful because they give an appreciation of overall data variance occurring at both the sampling and analytical stages. As they consist of samples from the survey itself, they may reveal limitations in the data that are specific to the area and which may not show up in the reference standards. Scatter plots of 62 variables for sediment analyses along with the Spearman correlation coefficient (r) were prepared. A selection of 24 of these is shown in Figure 2. The higher the absolute value of 'r' the better the correlation, with ± 1.00 being a perfect correlation.

A comparison of correlation coefficients for the same element by different methods is a useful way to select the more reliable method. For example, As and Zr by ICP give preferable results compared to those results by INAA. For some other elements (*e.g.*, Ce, Cr and La) the two methods give similar reproducibility.

Scatter plots of 19 variables from site duplicates in water are shown in Figure 3. Generally, the correlations are stronger between water duplicates than between sediment duplicates. Many elements have strong correlations ($r>0.9$). This is not surprising because water is a more homogeneous medium than sediment and, unlike sediment, is not prone to compositional modifications within a lake due to variations in depth, LOI, Fe/Mn oxide scavenging and bottom currents.

Between-laboratory Variations. The sediment samples collected in 2006 and those collected in 2007 were analyzed using INAA by two different laboratories. Those from 2006 were analyzed by Becquerel Laboratories and those from 2007 by ActLabs. Evaluation of the LKSD standards for the INAA analyses indicates a problem in directly comparing some of the analyses from the two laboratories.

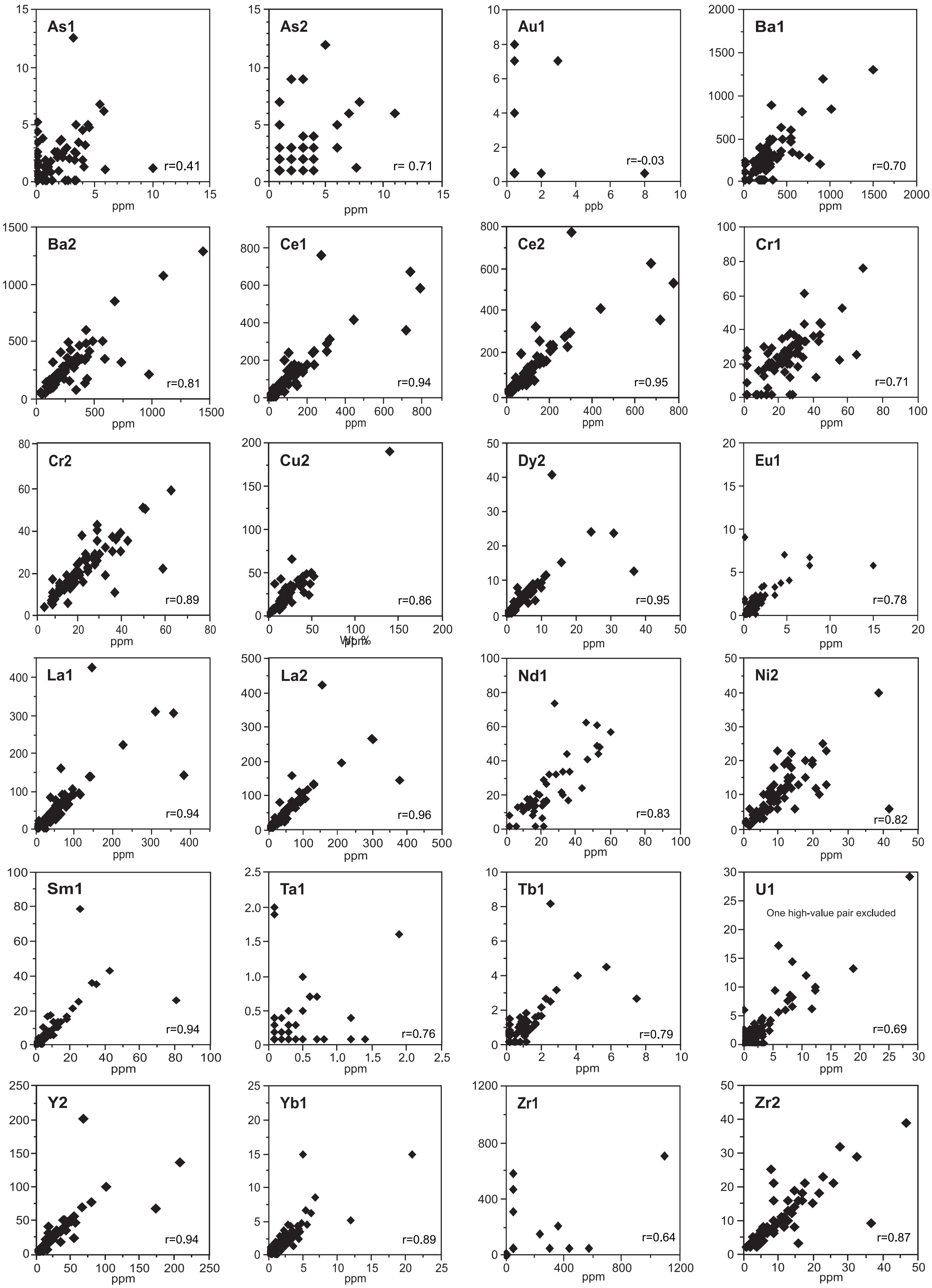

Figure 2. *Scatter plots of As1, As2, Au1, Ba1, Ba2, Ce1, Ce2, Cr1, Cr2, Cu2, Dy2, Eu2, La1, La2, Nd1, Ni2, Sm1, Ta1, Tb1, U1, Y2, Yb1, Zr1 and Zr2 in site duplicates of lake sediment.*

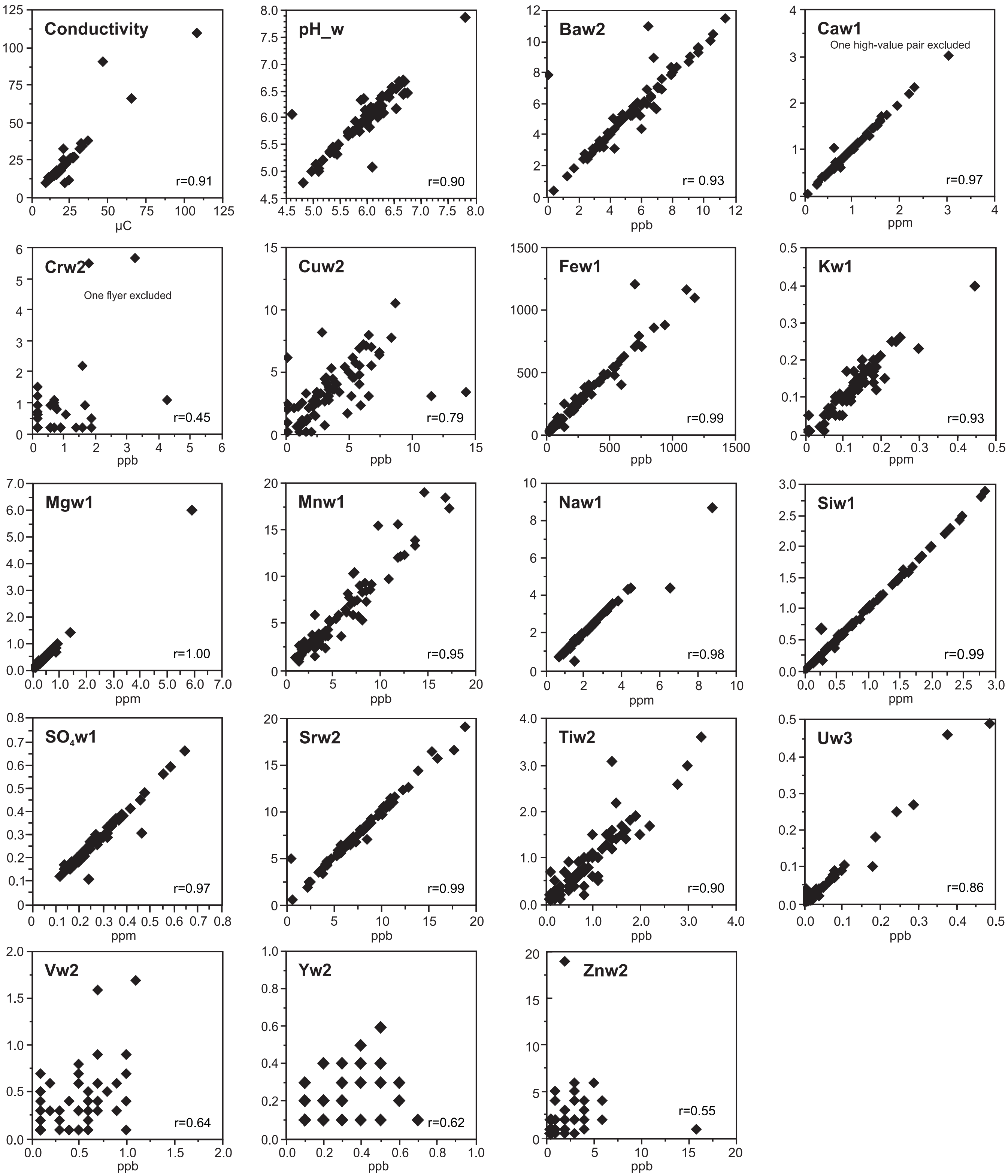

Figure 3. *Scatter plots of conductivity, pH, Ba, Ca, Cr, Cu, Fe, K, Mg, Mn, Na, Si, So$_4$, Sr, Ti, U, V, Y and Zn in site duplicates of lake water.*

Table 4. Summary statistics for lake-sediment data; element values in ppm unless otherwise indicated (N=2129)

Element/ Variable	Median	Mean (Arithmetic)	Mean (Geometric)	Deviation (Arithmetic)	Deviation (Logarithmic)	Minimum	Maximum
Ag6	<0.10	0.06	0.05	0.11	0.12	0.05	2.72
Al2, wt. %	2.19	2.59	2.05	1.64	0.33	0.05	8.38
As1	0.8	1.6	0.7	2.05	0.55	0.2	30
As2	<2	2.2	1.7	1.80	0.27	1	27
Au1, ppb	<1	0.7	0.6	1.06	0.21	0.5	12
Ba1	240	307	178	291	0.52	25	3000
Ba2	231	336	247	287	0.35	20	2819
Be2	0.7	0.9	0.6	0.97	0.38	0.1	19.5
Br1	30.0	34	28	23.19	0.30	1	315
Ca1, wt %	<1	0.8	0.7	0.68	0.24	0.5	5
Ca2, wt. %	0.61	0.95	0.68	1.66	0.31	0.01	31.68
Cd2	<0.1	0.2	0.1	0.19	0.38	0.1	2.1
Ce1	55	93	56	108	0.46	2	982
Ce2	60	97	62	104	0.44	1	919
Co1	5	8	5	11.9	0.46	1	220
Co2	7	10	7	12.0	0.39	1	171
Cr1	20	23	15	19.9	0.48	2	350
Cr2	18	22	17	15.5	0.33	1	134
Cs1	<1	0.4	0.3	0.66	0.30	0.2	13
Cu2	12	16	12	14.3	0.37	1	181
Dy2	2.9	4.5	2.8	5.00	0.45	0.1	86
Eu1	0.9	1.3	0.9	1.56	0.41	0.2	24
F9	197	266	203	207	0.33	14	1500
Fe1, wt.%	1.34	2.03	1.35	2.05	0.40	0.1	22.6
Fe2, wt.%	1.35	2.04	1.32	2.06	0.42	0.03	21.37
Hf1	2	3.8	1.8	5.91	0.51	0.5	66
K2, wt. %	0.27	0.57	0.30	0.75	0.50	0.01	7.19
La1	28	46	29	52.2	0.43	1	675
La2	29	47	31	50.0	0.42	1	653
Li2	3.3	4.6	3.2	4.41	0.39	0.2	61.2
LOI, wt.%	33.4	35	30	16.96	0.24	1.3	98.4
Lu1	0.24	0.33	0.21	0.37	0.44	0.02	9.34
Mg2, wt.%	0.24	0.39	0.27	0.38	0.36	0.03	3.70
Mn2	238	440	247	860	0.44	18	20049
Mo1	0.2	1.94	0.50	5.43	0.63	0.2	117
Mo2	0.50	1.45	0.87	3.80	0.35	0.5	124
Na1, wt.%	0.26	0.50	0.30	0.56	0.44	0.01	3.20
Na2, wt.%	0.27	0.53	0.30	0.60	0.47	0.02	3.26
Nb2	4	6	4	5.33	0.37	1	50
Nd1	15	17	12	13.49	0.41	2	126
Ni2	9	11	8	8.54	0.35	1	89
P2	1117	1399	1126	951	0.29	69	7617
Pb2	5	7	5	5.46	0.34	1	50
Rb1	<5	12	4.80	19.2	0.54	2	170.0
Rb2	10.0	18	10	21.3	0.50	1	203
Sb1	<0.5	0.2	0.0	1.84	0.51	0.02	54
Sc1	4.7	5.8	4.5	4.04	0.33	0.2	34.3
Sc2	5.5	6.7	5.3	4.39	0.34	0.1	33
Se1	<1	0.5	0.5	0.00	0.00	0.5	0.5
Sm1	4.1	7.2	4.1	9.55	0.48	0.1	170
Sr2	76	119	87	108	0.34	8	669
Ta1	<0.2	0.3	0.2	0.44	0.39	0.1	3.9
Tb1	<0.5	1	0	1	0.43	0.2	16
Th1	3.6	4.3	3.4	3.11	0.32	0.1	30.4
Ti2	13.49	1922	1326	1804	0.40	25	22125
U1	2	4	1	15.92	0.75	0.1	469
V2	38	44	33	29.47	0.38	1	236
W1	<1	0	0	0.40	0.17	0.2	8
Y2	16	25	16	25.70	0.41	1	387
Yb1	2	2	1	2.24	0.44	0.1	22
Zn2	40	51	39	42.39	0.32	5	535
Zr1	<100	134	76	228.44	0.37	50	2400
Zr2	9	15	9	15.42	0.43	1	122
Lake area (km2)	0.1	0.2	0.1	0.97	0.60	0.0005	36.92
Lake Depth (m)	2.5	3.7	2.5	3.31	0.33	0.2	24

Table 5. Summary statistics for lake-water data; element values in ppb unless otherwise indicated (N=2234)

Element/ Variable	Detection Limit	Percentage of samples <D.L.	Median	Mean (Arithmetic)	Mean (Geometric)	Standard Deviation (Arithmetic)	Standard Deviation (Logarithmic)	Minimum	Maximum
Al	1	0	154	184	136	131.2	0.38	1	1031
As	2	82	<2.0	1	1	0.8	0.17	1	8
Ba	0.1	0	5.2	6.0	5.0	3.99	0.29	0.1	60.6
Be	0.1	97	<0.1	<0.1	<0.1	0.02	0.07	0.05	0.4
Ca, ppm	N.A.	0	0.97	1.51	0.95	3.63	0.33	0.04	48.48
Cd	1	99.9	<1	<1	<1	0.00	0.00	0.5	0.5
Co	1	99.9	<1	<2	<2	0.02	0.01	0.5	1
Cr	0.5	73	<0.5	<0.5	<0.5	2.26	0.36	0.2	98.8
Cu	0.5	19	3.1	3.4	2.0	3.08	0.55	0.2	62.7
F	2	13	21	26	14	24.3	0.58	1	277
Fe	10	1	235	315	202	293	0.46	5	2905
K, ppm	0.02	11	0.13	0.14	0.10	0.10	0.43	0.01	1.66
Li	0.1	30	0.3	0.3	0.2	0.30	0.45	0.10	6.7
Mg, ppm	0.01	0	0.52	0.65	0.51	0.89	0.26	0.01	11.15
Mn	0.50	1	4.8	6.0	4.5	6.04	0.34	0.2	124
Mo	1	91	<1	<1	<1	0.59	0.19	0.5	6
Na, ppm	N.A.	0	1.63	1.97	1.71	1.48	0.22	0.15	44.31
Ni	1.0	92	<1	<1	<1	3.42	0.19	0.5	111
P	5	64	<5	<5	<5	4.2	0.30	2	66
Pb	1	86	<1	<1	<1	1.61	0.30	0.2	51
Si, ppm	0.01	0	0.80	1.02	0.62	0.84	0.54	0.01	5.01
SO_4, ppm	0.01	0	0.26	0.30	0.26	0.19	0.21	0.03	3.86
Sr	N.A.	0	7.4	8.3	7.0	5.38	0.27	0.3	51.2
Ti	0.1	6	0.8	1.0	0.7	0.90	0.44	0.1	9.6
U	0.005	2	0.021	0.046	0.024	0.072	0.47	0.002	0.842
V	0.2	45	0.2	0.4	<0.2	0.35	0.39	0.1	7.5
Y	0.1	47	0.1	0.2	<0.1	0.20	0.40	0.1	3
Zn	1.0	16	2	2.4	1.6	7.30	0.33	0.5	209
Conductivity, µS	N.A.	0	19.8	24.3	20.7	25.17	0.20	7	300
pH	N.A.	0	6.00	5.97	N.A.	0.61	N.A.	4.3	8.46

* N.A. not applicable; ** pH is defined as a logarithmic value

Accuracy for both laboratories was evaluated by comparing their 96 analyses of the LKSD standards with the recommended values. ‘Accuracy’ is how close the value of the mean analysis of a given element comes to the recommended value. Of the 96 mean determinations, Becquerel was more accurate for 62 and ActLabs was more accurate for 9.

Precision was determined by comparing the standard deviations of the LKSD standards. ‘Precision’ is a measure of the reproducibility of an analysis. This can be evaluated by comparing the standard deviations for an element by the two laboratories. There were 96 standard deviations calculated for the four standards for each lab. Of these, Becquerel had 93 standard deviations that were smaller than the corresponding value for ActLabs’ analyses and ActLabs had 3 standard deviations that were smaller than the corresponding Becquerel value. From this it is apparent that for nearly all elements, Becquerel had more precise analyses.

DESCRIPTION AND DISCUSSION OF RESULTS

Statistical Analysis

Summary Statistics. To quantify the range and distribution characteristics of the element populations, summary statistics have been calculated for the sediment (Table 4) and water data (Table 5). Analyses of the second sample of site duplicate pairs are excluded. Statistics tabulated include the median, arithmetic mean, geometric mean, arithmetic standard deviation, logarithmic standard deviation, minimum and maximum. Both the geometric and logarithmic means are included because the distributions of most element populations are more log-normal than normal.

Correlation Analysis of Sediment Data. Table 6 provides a matrix of Spearman correlation coefficients of selected elements and variables that may be associated with

Table 6. Spearman correlation coefficients (r) for selected elements and variables in lake sediment (N=2097; for F9 N=721)

	Au1	Ce1	Co2	Cr1	Cu2	Dy2	Eu1	Fe1	La2	Lu1	Mg2	Mn2	Mo2	Ni2	Tb1	U1	Y2	Yb1	Zn2	Depth	LOI
Ag6	0.04	-0.02	0.04	0.01	0.06	-0.03	-0.03	0.06	-0.03	-0.03	-0.03	0.05	-0.02	0.06	-0.03	0.00	-0.03	-0.03	0.01	0.05	0.03
Au1	1.00	-0.07	0.06	0.10	0.11	-0.05	-0.03	0.03	-0.06	-0.03	0.02	0.01	0.02	0.13	-0.11	-0.01	-0.05	-0.04	0.00	0.08	0.03
Ba2	-0.02	0.49	0.65	0.39	-0.14	0.53	0.60	0.64	0.49	0.64	0.84	0.75	-0.01	0.33	0.36	0.14	0.55	0.63	0.66	-0.04	-0.45
Be2	-0.05	0.83	0.63	0.31	0.10	0.89	0.82	0.72	0.82	0.85	0.55	0.72	0.35	0.22	0.70	0.49	0.89	0.90	0.81	0.19	-0.28
Ca2	0.08	0.17	0.65	0.51	-0.10	0.25	0.36	0.53	0.17	0.41	0.86	0.65	-0.03	0.51	0.05	0.07	0.28	0.39	0.51	-0.10	-0.41
Cd2	0.05	0.25	0.25	0.15	0.46	0.29	0.22	0.29	0.25	0.19	-0.11	0.18	0.36	0.20	0.26	0.27	0.29	0.22	0.37	0.39	0.33
Ce1	-0.07	1.00	0.42	0.10	0.13	0.93	0.82	0.60	0.98	0.82	0.34	0.53	0.38	0.01	0.81	0.49	0.93	0.88	0.70	0.23	-0.12
Co2	0.06	0.42	1.00	0.64	0.23	0.51	0.56	0.85	0.40	0.60	0.75	0.90	0.20	0.71	0.26	0.27	0.52	0.59	0.81	0.13	-0.38
Cr1	0.10	0.10	0.64	**1.00**	0.34	0.17	0.27	0.50	0.07	0.33	0.53	0.51	0.04	0.70	-0.06	0.16	0.17	0.30	0.45	0.13	-0.25
Cu2	0.11	0.13	0.23	0.34	**1.00**	0.12	0.10	0.11	0.15	0.02	-0.11	0.04	0.33	0.39	-0.01	0.22	0.10	0.04	0.21	0.64	0.38
Dy2	-0.05	0.93	0.51	0.17	0.12	**1.00**	0.85	0.67	0.93	0.88	0.40	0.61	0.39	0.12	0.81	0.53	0.99	0.93	0.77	0.20	-0.18
Eu1	-0.03	0.82	0.56	0.27	0.10	0.85	**1.00**	0.69	0.82	0.81	0.48	0.63	0.27	0.22	0.67	0.40	0.85	0.85	0.76	0.15	-0.23
F9	-0.08	0.35	0.64	0.35	-0.29	0.40	0.47	0.61	0.34	0.53	0.82	0.68	0.08	0.59	0.42	0.09	0.41	0.48	0.63	-0.22	-0.51
Fe1	0.03	0.60	0.85	0.50	0.11	0.67	0.69	**1.00**	0.58	0.73	0.67	0.88	0.20	0.52	0.44	0.29	0.67	0.73	0.84	0.12	-0.36
Hf1	-0.05	0.45	0.56	0.32	-0.32	0.48	0.51	0.58	0.43	0.62	0.79	0.66	-0.01	0.24	0.37	0.17	0.51	0.61	0.54	-0.24	-0.53
K2	-0.02	0.38	0.60	0.39	-0.27	0.42	0.47	0.58	0.37	0.58	0.91	0.70	-0.05	0.31	0.26	0.12	0.44	0.55	0.54	-0.19	-0.58
La1	-0.06	0.98	0.40	0.07	0.15	0.93	0.82	0.58	**1.00**	0.80	0.32	0.50	0.39	0.00	0.80	0.47	0.93	0.87	0.69	0.24	-0.10
Lu1	-0.03	0.82	0.60	0.33	0.02	0.88	0.81	0.73	0.80	**1.00**	0.56	0.69	0.26	0.25	0.69	0.43	0.89	0.93	0.77	0.08	-0.31
Mg2	0.02	0.34	0.75	0.53	-0.11	0.40	0.48	0.67	0.32	0.56	**1.00**	0.78	-0.02	0.51	0.22	0.12	0.43	0.54	0.65	-0.12	-0.53
Mn2	0.01	0.53	0.90	0.51	0.04	0.61	0.63	0.88	0.50	0.69	0.78	**1.00**	0.16	0.53	0.37	0.26	0.62	0.69	0.82	0.07	-0.45
Mo2	0.02	0.38	0.20	0.04	0.33	0.39	0.27	0.20	0.39	0.26	-0.02	0.16	**1.00**	0.07	0.33	0.48	0.37	0.32	0.30	0.34	0.14
Na2	0.00	0.30	0.64	0.40	-0.23	0.34	0.41	0.57	0.29	0.52	0.91	0.71	-0.06	0.36	0.17	0.07	0.36	0.49	0.51	-0.22	-0.59
Nb2	-0.03	0.66	0.74	0.37	-0.08	0.72	0.68	0.81	0.65	0.77	0.77	0.85	0.17	0.30	0.52	0.32	0.73	0.78	0.77	0.01	-0.44
Nd1	0.07	0.84	0.47	0.39	0.34	0.81	0.80	0.55	0.87	0.69	0.35	0.48	0.26	0.30	0.43	0.33	0.81	0.73	0.58	0.26	-0.17
Ni2	0.13	0.01	0.71	0.70	0.39	0.12	0.22	0.52	0.00	0.25	0.51	0.53	0.07	**1.00**	-0.11	0.11	0.12	0.20	0.48	0.12	-0.26
Pb2	-0.06	0.45	0.40	0.13	-0.30	0.49	0.45	0.50	0.44	0.54	0.55	0.53	0.09	0.05	0.45	0.23	0.51	0.56	0.44	-0.29	-0.29
Rb2	-0.02	0.38	0.64	0.45	-0.18	0.43	0.49	0.60	0.37	0.58	0.88	0.72	0.00	0.36	0.27	0.18	0.46	0.57	0.57	-0.13	-0.54
Sb1	-0.09	0.40	0.07	-0.07	-0.12	0.38	0.30	0.19	0.37	0.32	0.11	0.14	0.15	-0.11	0.47	0.23	0.39	0.36	0.24	-0.03	-0.02
Sc2	0.00	0.66	0.79	0.51	0.04	0.75	0.76	0.82	0.65	0.82	0.82	0.85	0.12	0.44	0.51	0.27	0.75	0.82	0.84	0.04	-0.40
Sm1	-0.09	0.96	0.42	0.08	0.06	0.94	0.84	0.61	0.95	0.85	0.37	0.54	0.32	0.01	0.80	0.45	0.94	0.89	0.70	0.17	-0.19
Sr2	0.01	0.30	0.64	0.42	-0.19	0.33	0.44	0.59	0.29	0.49	0.90	0.71	-0.06	0.38	0.16	0.04	0.36	0.47	0.55	-0.15	-0.48
Tb1	-0.11	0.81	0.26	-0.06	-0.01	0.81	0.67	0.44	0.80	0.69	0.22	0.37	0.33	-0.11	**1.00**	0.46	0.82	0.76	0.57	0.12	-0.05
Th1	-0.03	0.72	0.46	0.32	0.16	0.70	0.61	0.52	0.72	0.70	0.46	0.53	0.34	0.18	0.50	0.50	0.71	0.73	0.53	0.14	-0.23
Ti2	-0.01	0.47	0.70	0.43	-0.12	0.52	0.55	0.65	0.46	0.63	0.90	0.77	0.04	0.34	0.33	0.18	0.53	0.63	0.62	-0.08	-0.48
U1	-0.01	0.49	0.27	0.16	0.22	0.53	0.40	0.29	0.47	0.43	0.12	0.26	0.48	0.11	0.46	**1.00**	0.53	0.50	0.35	0.22	-0.04
V2	0.06	0.52	0.81	0.55	0.40	0.59	0.59	0.81	0.51	0.61	0.59	0.76	0.26	0.56	0.31	0.28	0.59	0.61	0.77	0.32	-0.24
Y2	-0.05	0.93	0.52	0.17	0.10	0.99	0.85	0.67	0.93	0.89	0.43	0.62	0.37	0.12	0.82	0.53	**1.00**	0.94	0.77	0.19	-0.20
Yb1	-0.04	0.88	0.59	0.30	0.04	0.93	0.85	0.73	0.87	0.93	0.54	0.69	0.32	0.20	0.76	0.50	0.94	**1.00**	0.78	0.12	-0.28
Zn2	0.00	0.70	0.81	0.45	0.21	0.77	0.76	0.84	0.69	0.77	0.65	0.82	0.30	0.48	0.57	0.35	0.77	0.78	**1.00**	0.23	-0.25
Zr2	-0.02	0.43	0.66	0.43	-0.24	0.49	0.51	0.66	0.41	0.65	0.89	0.76	-0.01	0.34	0.30	0.17	0.51	0.63	0.59	-0.19	-0.57
Depth_m	0.08	0.23	0.13	0.13	0.64	0.20	0.15	0.12	0.24	0.08	-0.12	0.07	0.34	0.12	0.12	0.22	0.19	0.12	0.23	**1.00**	0.34
LOI	0.03	-0.12	-0.38	-0.25	0.38	-0.18	-0.23	-0.36	-0.10	-0.31	-0.53	-0.45	0.14	-0.26	-0.05	-0.04	-0.20	-0.28	-0.25	0.34	**1.00**

r>|0.04| is significant at the 0.05 confidence level; r>|0.06| is significant at the 0.01 confidence level.

REE, uranium, gold or base-metal mineralization. Coefficients for which r≥ |0.80| are coloured red to emphasize element pairs with strong correlations. Of the variables in the vertical columns, iron (Fe1), depth and loss-on-ignition (LOI) may be considered environmental parameters independent of bedrock composition that may influence the accumulation of elements in sediment. Of the base metals, only cobalt (Co2), zinc (Zn2) and niobium (Nb2) show strong correlations with iron where r=0.85, r=0.84 and r=0.81 respectively, suggesting the presence of iron hydroxide scavenging. The strongest base-metal correlation with depth is copper (r=0.64). With LOI, the strongest correlation is also with copper (r=0.38).

An examination of the correlation coefficients shows that nearly all analyzed REE (Ce, Dy, Eu, La, Lu, Nd, Sm, Tb and Yb) have strong (>0.8) mutual correlations. Somewhat of an exception is terbium (Tb1), which has slightly weaker correlations in all cases. Most of these REEs also correlate strongly with beryllium (Be2; r=0.81 to 0.90) and moderately to strongly with scandium (Sc2). All of these REEs also correlate strongly with the transition metal, yttrium (Y2), which behaves like a REE.

There are no strong correlations of gold and base metals with the other elements. Gold has no strong or moderate correlations. Copper has weak correlations with nickel (r=0.39) and molybdenum (r=0.33). Molybdenum has a moderate correlation with uranium (r=0.48). Aside from the weak correlation with copper, correlations with nickel include cobalt (r=0.71) and chromium (r=0.70). Uranium has moderate correlations with the REE, with thorium (r=0.50) and with molybdenum (r=0.48), as mentioned above.

Correlation Analysis of Water Data. Spearman correlation coefficients were calculated for those analyses for which more than 10% of the samples exceeded the detection limit (Table 7). Correlations are weaker amongst the water variables compared to correlations among sediment data. Consequently, to highlight the more robust correlations, coefficients for which r≥ |0.70| are coloured red. Some of the strongest correlations are among pH, calcium and magnesium, suggesting that these variables may be useful guides to magmatic differentiation of bedrock in the catchment basin. Two of the strongest element correlations with uranium are yttrium (r=0.46) and fluoride (r=0.32) suggesting a granophile association. Correlations are weak among the base metals.

Element Distribution in Lake Sediment and Water

Symbol dot plot maps of the variables were produced, in most instances, using natural breaks (Jenk's Optimization). These breaks are naturally occurring divisions in the data, and often reflect geochemical or mineralogical processes. In some cases, the intervals were adjusted manually to better display the dispersion patterns or emphasize higher values. For discussion purposes the term 'high value' will refer to the highest interval on the associated dot plot map shown by red dots, and the term 'elevated value' will refer to the second highest interval shown by orange dots. The bedrock polygons are from the digital 1:1 000 000-scale geology map of Labrador (Wardle *et al.*, 1997). Reference to the expanded geological legend (Figure 4) may be useful when examining the symbol plots. References to NTS map areas will be made frequently and these can be determined from the index map (Figure 1).

Histograms with overlaid cumulative frequency plots are included in each figure. These show the extent and shape of the distribution. The horizontal axes on the histograms are logarithmic because most lake-sediment and water datasets tend to approximate log-normal distributions rather than normal distributions. The cumulative frequency curves allow the reader to determine what percentile ranges apply to each dot symbol class. Inflections in the curve reflect underlying breaks in the population, possibly denoting changes in bedrock composition.

The following discussion groups elements and variables sharing geochemical or geological affinities. Examples of the REE distribution in sediment are lanthanum (La2), ytterbium (Yb1) and the associated element yttrium (Y2) (Figures 5 to 7). The REE have similar distribution patterns because they have similar chemical properties in the surficial environment. The biggest visual difference is due to the Jenks algorithm selecting different population break points with the results that some REE have proportionally more high and elevated values than others. In all cases, the red and orange dots are concentrated in the southern portion of the survey area and are from lake-catchment basins located over granites and similar rock types. Several samples from lakes located in NTS map area 3D/5 in the southeastern end of the K-feldspar megacrystic granite belt (Unit P3gm) have elevated values and one high value of a REE. This area is partially coincident with a belt of recently mapped alkali-feldspar syenitic bodies that are enriched in REE (Gower, 2010).

A plot of yttrium in water (Yw2) is shown in Figure 8. The pattern in water differs considerably from that of Y in sediment. The southern granites have high sediment values but have relatively subdued values in water. Similar to Y in sediment, Yw2 does strongly reflect the trend of alkali-feldspar syenitic bodies. As well, seven samples along strike in areas mapped as Unit P3a (anorthositic and related rocks

Table 7. Spearman correlation coefficients (r) for selected elements and variables in lake water (N=2222).

	conduct	Alw2	Asw2x	Baw2	Caw1	Crw2	Cuw2	Fw9	Few1	Kw1	Liw2	Mgw1	Mnw1	Naw1	Pw2	Pbw2	SO4w1	Tiw2	Uw3	Yw2	Znw2
pH_w	0.25	-0.51	0.14	0.40	0.73	-0.15	0.03	0.15	-0.10	-0.01	0.14	0.54	-0.35	0.02	-0.06	-0.09	0.36	-0.48	0.06	-0.16	-0.22
conduct	**1.00**	0.26	0.25	0.20	0.60	-0.08	0.18	0.12	0.13	0.36	0.01	0.85	0.09	0.81	0.25	-0.08	0.72	0.19	0.26	0.08	0.18
Alw2	0.26	**1.00**	-0.06	-0.13	-0.08	0.14	0.09	0.23	0.33	0.16	0.03	0.12	0.44	0.48	0.29	0.02	0.09	0.78	0.36	0.49	0.28
Asw2x	0.25	-0.06	**1.00**	0.12	0.17	-0.02	0.18	-0.13	-0.09	0.14	0.09	0.23	-0.04	0.24	0.04	-0.09	0.20	-0.08	0.10	-0.05	0.05
Baw2	0.20	-0.13	0.12	**1.00**	0.42	-0.08	-0.05	0.03	0.16	0.07	0.05	0.40	0.01	0.06	0.20	-0.09	0.38	-0.12	-0.06	0.04	0.08
Caw1	0.60	-0.08	0.17	0.42	**1.00**	-0.07	0.04	0.24	0.21	0.08	0.03	0.78	-0.08	0.33	0.22	-0.08	0.59	-0.04	0.13	-0.01	-0.06
Crw2	-0.08	0.14	-0.02	-0.08	-0.07	**1.00**	0.05	0.09	0.16	-0.02	-0.00	-0.13	0.15	-0.04	0.08	0.09	-0.06	0.20	0.04	0.14	-0.05
Cuw2	0.18	0.09	0.18	-0.05	0.04	0.05	**1.00**	-0.03	-0.06	0.24	-0.03	0.12	0.02	0.23	0.02	-0.01	0.04	0.09	0.21	0.19	0.07
Fw9	0.12	0.23	-0.13	0.03	0.24	0.09	-0.03	**1.00**	0.32	-0.22	0.11	0.15	0.17	0.06	0.06	0.09	-0.01	0.30	0.32	0.44	-0.15
Few1	0.13	0.33	-0.09	0.16	0.21	0.16	-0.06	0.32	**1.00**	-0.20	-0.04	0.13	0.40	0.03	0.45	0.06	0.02	0.54	-0.12	0.24	-0.05
Kw1	0.36	0.16	0.14	0.07	0.08	-0.02	0.24	-0.22	-0.20	**1.00**	-0.09	0.33	0.04	0.52	0.07	-0.10	0.30	0.07	0.34	0.07	0.35
Liw2	0.01	0.03	0.09	0.05	0.03	-0.00	-0.03	0.11	-0.04	-0.09	**1.00**	0.05	-0.01	-0.04	-0.09	-0.02	0.02	-0.07	0.12	0.15	-0.15
Mgw1	0.85	0.12	0.23	0.40	0.78	-0.13	0.12	0.15	0.13	0.33	0.05	**1.00**	-0.00	0.70	0.24	-0.14	0.76	0.05	0.23	0.03	0.13
Mnw1	0.09	0.44	-0.04	0.01	-0.08	0.15	0.02	0.17	0.40	0.04	-0.01	-0.00	**1.00**	0.18	0.17	-0.03	-0.07	0.41	0.24	0.35	0.14
Naw1	0.81	0.48	0.24	0.06	0.33	-0.04	0.23	0.06	0.03	0.52	-0.04	0.70	0.18	**1.00**	0.19	-0.11	0.62	0.32	0.40	0.21	0.30
Pw2	0.25	0.29	0.04	0.20	0.22	0.08	0.02	0.06	0.45	0.07	-0.09	0.24	0.17	0.19	**1.00**	0.04	0.24	0.42	-0.03	0.11	0.17
Pbw2	-0.08	0.02	-0.09	-0.09	-0.08	0.09	-0.01	0.09	0.06	-0.10	-0.02	-0.14	-0.03	-0.11	0.04	**1.00**	-0.11	0.12	-0.01	0.06	-0.04
Siw1	0.24	-0.01	0.11	0.49	0.46	-0.09	0.02	0.08	-0.04	0.13	0.10	0.45	0.05	0.21	-0.01	-0.09	0.35	-0.14	0.19	0.14	0.06
SO4w1	0.72	0.09	0.20	0.38	0.59	-0.06	0.04	-0.01	0.02	0.30	0.02	0.76	-0.07	0.62	0.24	-0.11	**1.00**	-0.01	0.05	-0.06	0.10
Srw2	0.57	-0.04	0.19	0.61	0.85	-0.08	0.05	0.19	0.21	0.09	0.09	0.77	-0.06	0.34	0.26	-0.10	0.64	-0.05	0.13	0.00	-0.04
Tiw2	0.19	0.78	-0.08	-0.12	-0.04	0.20	0.09	0.30	0.54	0.07	-0.07	0.05	0.41	0.32	0.42	0.12	-0.01	**1.00**	0.19	0.43	0.28
Uw3	0.26	0.36	0.10	-0.06	0.13	0.04	0.21	0.32	-0.12	0.34	0.12	0.23	0.24	0.40	-0.03	-0.01	0.05	0.19	**1.00**	0.46	0.10
Vw2	0.34	0.40	0.10	0.04	0.10	0.06	0.22	-0.02	0.17	0.34	-0.21	0.28	0.17	0.44	0.24	0.02	0.21	0.45	0.10	0.10	0.35
Yw2	0.08	0.49	-0.05	0.04	-0.01	0.14	0.19	0.44	0.24	0.07	0.15	0.03	0.35	0.21	0.11	0.06	-0.06	0.43	0.46	**1.00**	0.14
Znw2	0.18	0.28	0.05	0.08	-0.06	-0.05	0.07	-0.15	-0.05	0.35	-0.15	0.13	0.14	0.30	0.17	-0.04	0.10	0.28	0.10	0.14	**1.00**
depth_m	-0.11	0.05	0.00	0.00	-0.17	0.02	-0.00	0.02	-0.23	0.13	-0.01	-0.13	0.04	0.03	-0.25	-0.02	0.02	-0.12	0.03	-0.06	-0.11
area_km	-0.08	0.01	-0.03	-0.05	-0.05	-0.01	-0.04	0.09	-0.09	0.08	0.08	-0.07	0.02	0.03	-0.01	-0.05	0.01	-0.02	0.05	-0.06	-0.08

r>|0.07| is significant at the 0.05 confidence level; r>|0.09| is significant at the 0.01 confidence level.

in NTS map area 13A/09) have elevated to high values. This suggests that more detailed mapping might indicate the presence of syenitic rocks here as well. Farther along strike to the northwest, in an area where Gower (*ibid.*) has described alkali-feldspar syenitic bodies (NTS map area 3D/5), there is a cluster of four samples having elevated to high Yw2 contents. Finally, a cluster of samples, two with high values and one with an elevated value is located in NTS map area 13H/08 in an area mapped as intermediate intrusive plutons (Unit P3t). Another two-sample cluster is found in 13H/02 over a granitic pluton (Unit P3gr).

The distribution of uranium in sediment (U1) is shown in Figure 9. Most samples with high and elevated uranium values are concentrated in NTS areas 12P/16 and 13A/01 with three scattered samples in adjacent NTS areas 3D/04 and 12P/15. Most of the samples are from lakes overlying granites and associated rocks of Unit P-Mgs, and two samples are from lakes overlying Unit P-Msv. A cluster of samples in NTS map area 12P/16 that have high and elevated uranium values are found in proximity to one of two known MODS uranium occurrences (12P/16 U002) in the survey area. One sample with 75 ppm U1 is from a lake located a few hundred metres east of the occurrences, another with 118 ppm U1 is from a pond about 1 km to the southwest and a third sample with 119 ppm U1 is from a pond about 1.5 km to the north.

The distribution of uranium in water (Uw3) is shown in Figure 10. Twelve samples having high uranium values and 26 having elevated values occur in lakes in the southern part of the survey area. Nearly all of the high value lakes overlie Unit P-Mgs, a felsic unit composed of granite, syenite, monzonite, granitoid gneiss, and minor diorite. The samples having high uranium values form three distinct clusters in NTS map areas 12P/16 and 13A/01. Farther north in NTS map area 3D/12,

SUPRACRUSTAL ROCKS

NEOPROTEROZOIC

NCs	Sandstone and nodular limestone (Labrador Gp.)
Ns	Sandstone and nodular limestone (Labrador Gp.)

MESOPROTEROZOIC

PALEO- AND/OR MESO-PROTEROZOIC

P-Msv	Metasedimentary and felsic volcanic rocks [1650 to 1450 Ma, Pinware terrane, southeastern GP]

PALEOPROTEROZOIC

P3sgn	Pelitic, migmatitic metasedimentary gneiss and minor psammitic gneiss at amphibolite to granulite facies

PLUTONIC ROCKS

M3gs	Late- to post- tectonic granite and syenite plutons [1080 to 956 Ma, southern GP]
M3mg	Monzonite to granite [Pinware terrane, southeastern GP]
M3gr	Syenite to granite [Pinware terrane, southeastern GP]
M2gr	Granite plutons [e.g., Upper North River pluton, ca. 1296 Ma, GP]
M1g	Granitoid rocks [1500 to 1420 Ma]
M1a	Anorthosite and other, locally layered, mafic rocks
M1lga	Layered gabbro-anorthosite-ultramafic intrusions [e.g., Kyfanan Lake intrusion]
P-Mg	K-feldspar-megacrystic granitoid plutons
P-Msy	Syenite, monzonite and diorite
P-Mgs	Granite, syenite, monzonite, diorite and derived gneiss [1650 to 1450 Ma]
P3gr	Granite, quartz monzonite, granodiorite, syenite and minor quartz diorite [e.g., ca.1650 Ma; Trans-Labrador batholith and coeval rocks in GP and MP]
P3a	Anorthosite and other, locally layered, mafic components [1645 to 1625 Ma]
P3ga	Mafic intrusive suites (gabbronorite, lesser diorite), some metamorphosed at amphibolite to granulite facies
P3t	Quartz diorite to granodiorite plutons
P3gm	K-feldspar-megacrystic granite and other granitoid plutonic rocks
P3gdn	Granodioritic orthogneiss (lesser quartz dioritic and granitic orthogneiss), commonly migmatitic; may include some Mesoproterozoic rocks in areas mapped only at reconnaissance scale

Figure 4. *Expanded geological legend for Figures 5-14 (GP – Grenville Province, MP – Makkovik Province).*

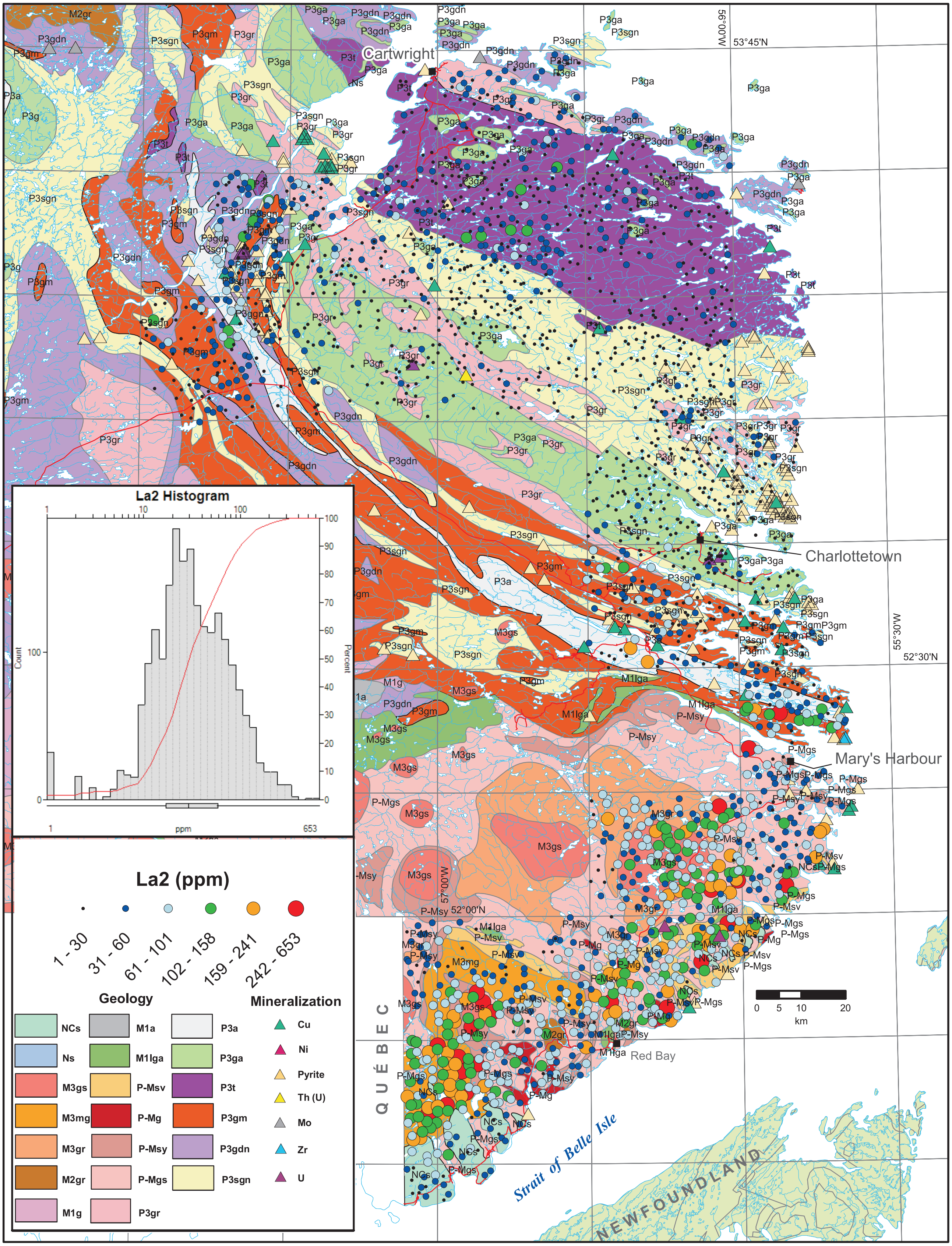

Figure 5. *Lanthanum (La2) in lake sediment.*

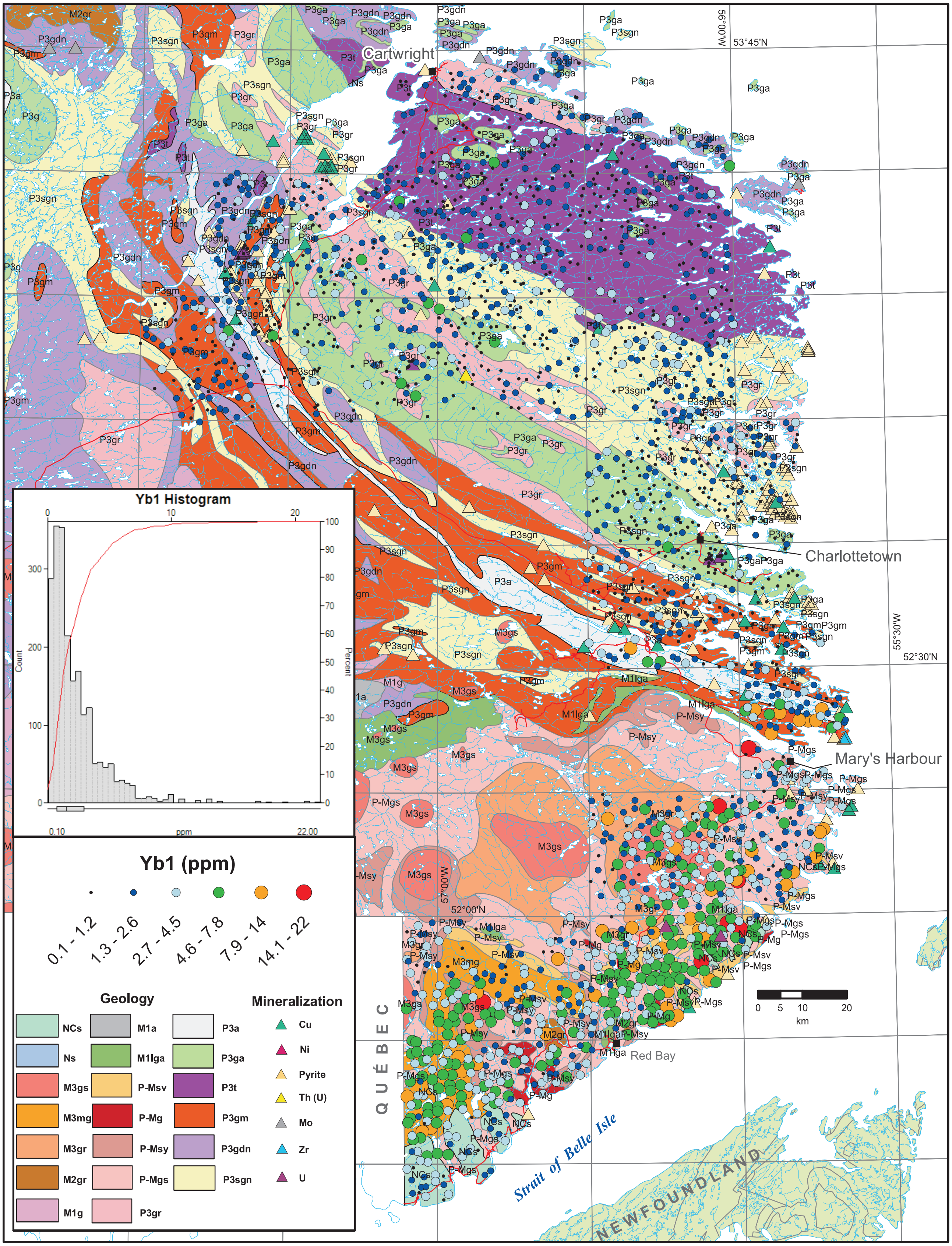

Figure 6. *Ytterbium (Yb1) in lake sediment.*

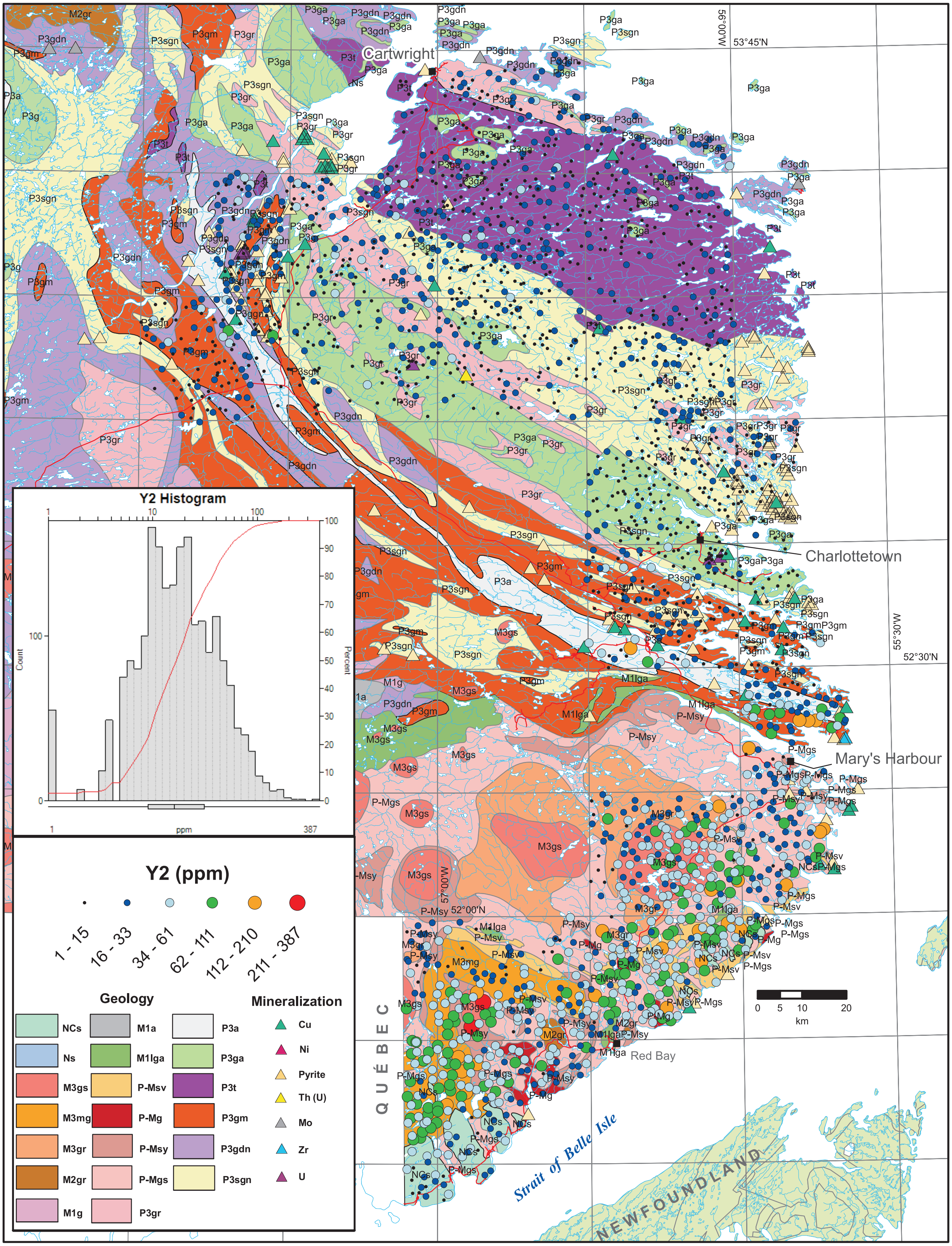

Figure 7. *Yttrium (Y2) in lake sediment.*

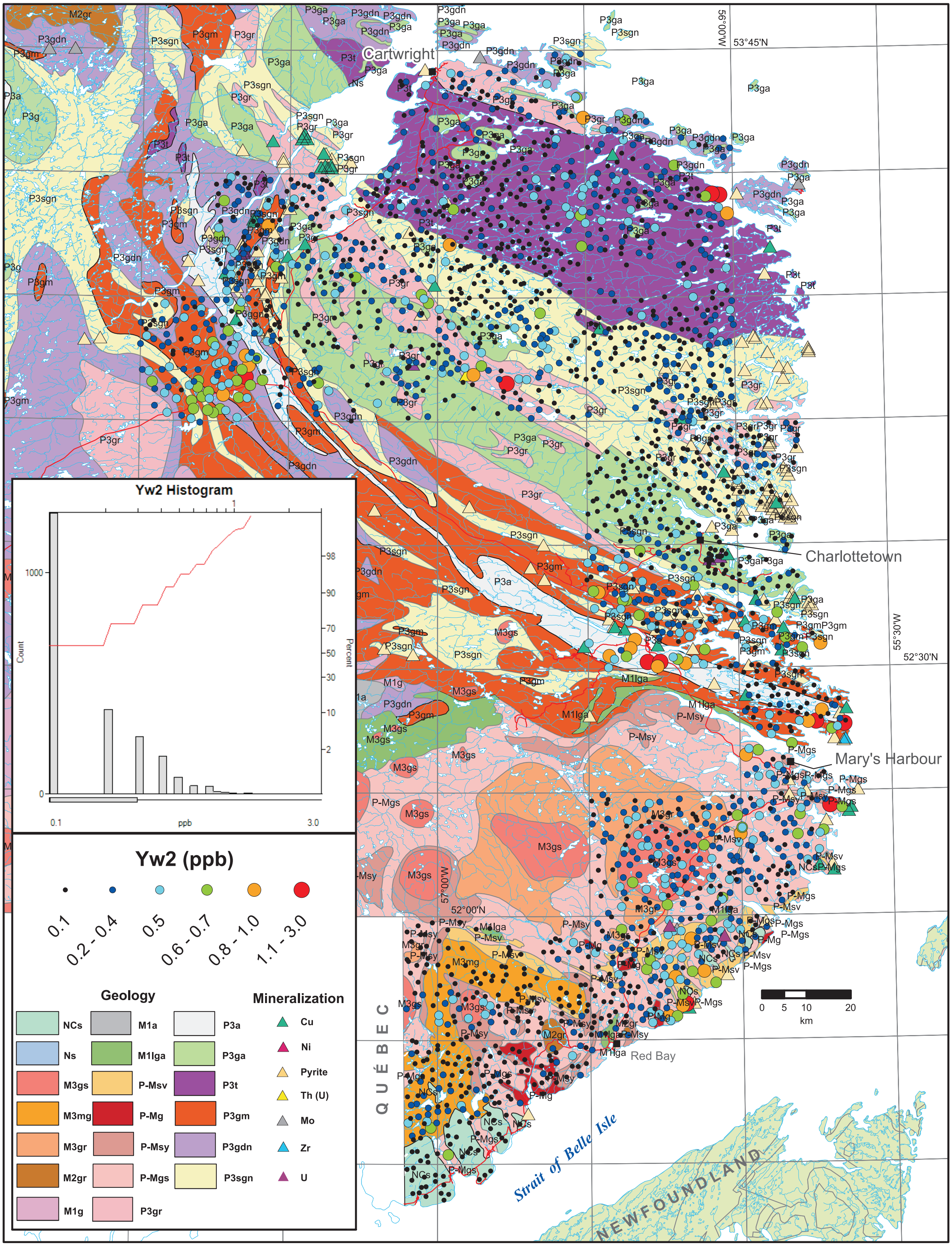

Figure 8. *Yttrium (Yw2) in lake water.*

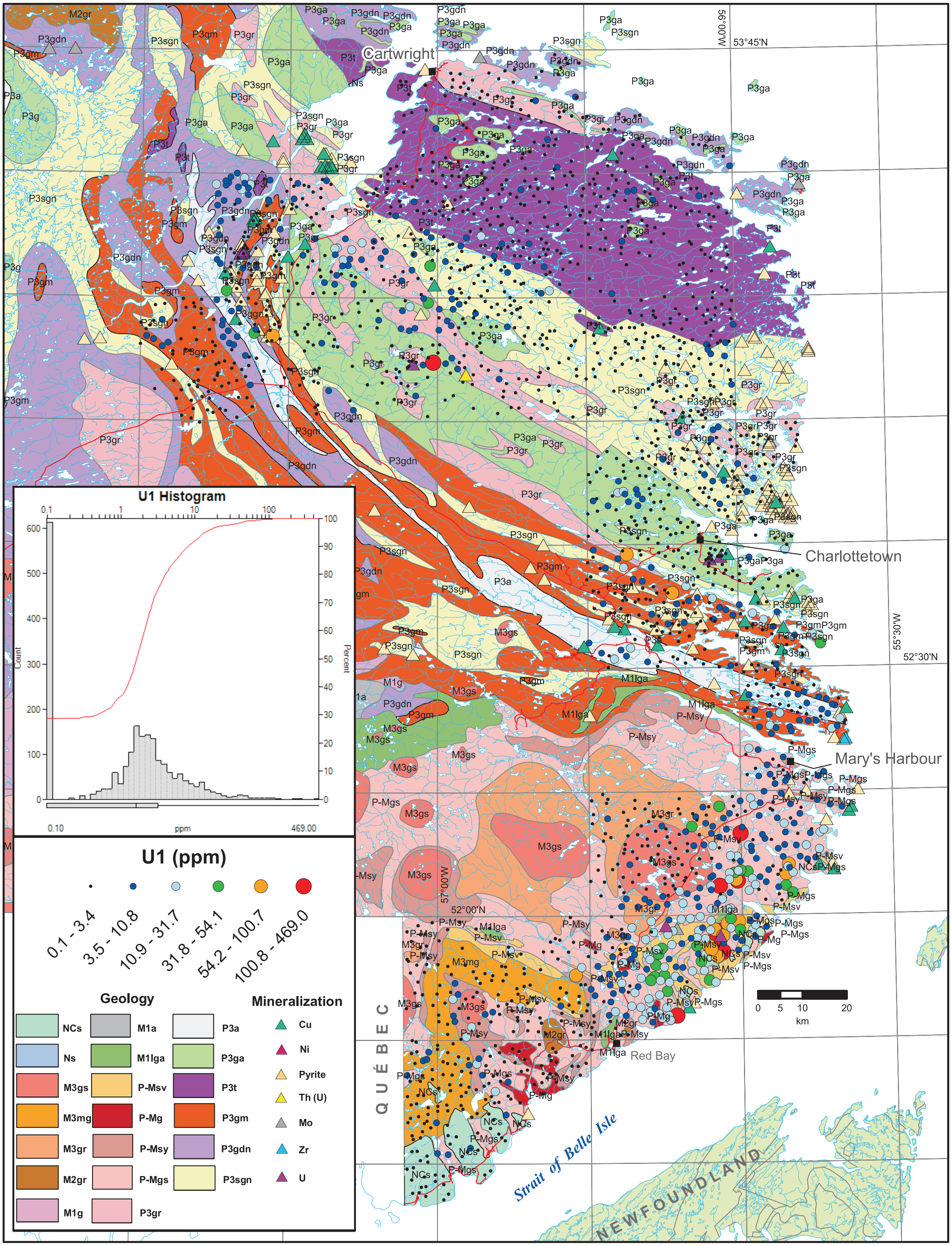

Figure 9. *Uranium (U1) in lake sediment.*

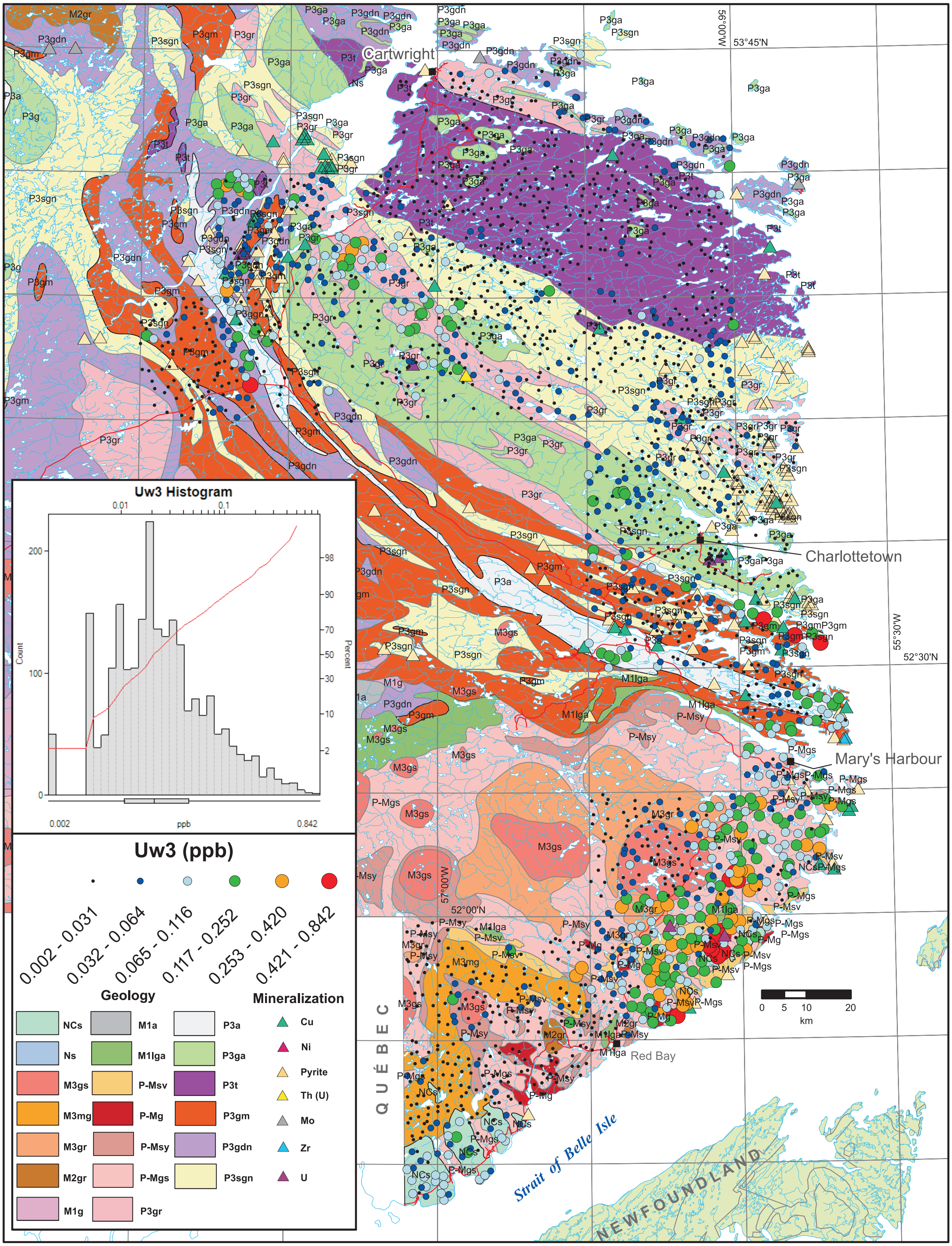

Figure 10. *Uranium (Uw3) in lake water.*

three other samples that have high uranium values form a cluster in lakes overlying the granite and granitoid rocks of Unit P3gm. Two other clusters of samples having moderate and elevated uranium values occur in NTS map areas 13H/05 and 13H/06. These also overlie granitic rocks.

The distribution of gold (Au1) is shown in Figure 11. Gold in lake sediment is commonly problematic to interpret. The data are characteristically noisy due to very low concentrations and perhaps the nugget effect. The Spearman correlation coefficient between pairs of site duplicate samples is -0.03, that is, not significant (Figure 2). The gold concentrations in the samples from the survey are quite low, with the highest interval being only 9 to 12 ppb Au1. All of the samples having high and elevated gold values are in the north half of the survey area and are found over a variety of rock types. These samples are scattered, although some are within a few kilometres of each other. In some areas, arsenic (As2) and/or antimony (Sb1) may act as pathfinders for gold mineralization. However, the statistical correlations in Table 5 indicate that there is no association between gold and either arsenic or antimony.

The distribution of copper (Cu2) is shown in Figure 12. There are several clusters and isolated samples having elevated and high values (NTS map areas 3D/5 and 13A/09). Unit P3a, consisting of leuconorite and associated rocks, has several such samples and also has two known Cu occurrences. Another large cluster of 13 samples having elevated values occurs in NTS map areas 3D/13 and 13A/16. These overlie the copper mineralized pelitic gneiss Unit P3sgn. Eight elevated and two high Cu values occur in NTS map areas 13H/7, 8 and 10 over Unit P3t consisting of quartz diorite, tonalite and granodiorite. Smaller clusters and isolated samples of elevated and high values occur elsewhere.

The distribution of the acidity (pH) of water samples is shown in Figure 13. The intervals are based on 5 quantile divisions, not the Jenks algorithm. Values, generally, reflect the nature of the bedrock underlying the catchment basins of the samples. Many of the most acidic samples ($pH<5.51$) are found in lakes overlying the granites and granitoids of Units P3gm and P3t. Some of the most alkaline samples ($pH>6.43$) are found over the limestones and sandstones of Unit NCs and the mafic rocks of Unit P3ga.

The distribution of fluoride (Fw9) in water is shown in Figure 14. It appears to be a very effective indicator of bedrock type. Samples having high and elevated values occur over highly differentiated felsic rocks such as Units M3gs, M3gr, P3gm in the south of the survey area. High and elevated values also occur in water samples from Units P3gr and P3gdn in the north. Many of these latter samples are close to the coast and may be affected by windblown contamination by seawater. Concentrations of elements such as sodium and strontium, which might indicate seawater contamination, are higher than average in these samples although not as proportionally high as the fluoride contents. Conversely, samples from lakes overlying mafic terrane such as Unit P3ga (gabbronorite, amphibolite and mafic granulite) have universally low fluoride contents.

SUMMARY AND CONCLUSIONS

1. Lake-sediment geochemical analyses are effective at delineating some known mineral occurrences and suggest, together with lake water analyses, the presence of other bedrock sources of mineralization not presently identified.

2. Several areas in the southern part of the survey area, which are predominantly granitic terrane, are distinguished by samples having high REE contents. These include, but are not limited to: dysprosium, lanthanum, terbium, and ytterbium. Yttrium in water has also been an effective indicator of rare-earth mineralization elsewhere. There are several areas having high REE content in lake water that appear to delineate a belt of alkali-feldspar syenitic rocks.

3. Although only two occurrences of uranium mineralization in the survey area are recorded in the MODS database, several sediment samples having very encouraging uranium contents are present including a cluster around one uranium occurrence in NTS area 12P/16. Most of these are over granitic rocks. The patterns of high values of uranium in water are broadly similar to those in sediment but also suggest a few other areas of interest such as in NTS map areas 13H/4 to 6 and 3D/12.

4. Several clusters of samples that have elevated copper values occur in the survey area. Many of the clusters are over rock units that are known to host copper mineralization (*see* Figure 9).

5. Some water analyses are useful as indicators of bedrock type or for differentiating phases within an individual unit. As an example, high levels of fluoride (Fw9) are generally found over highly differentiated granites.

ACKNOWLEDGMENTS

The author wishes to thank Chris Finch for his overseeing the many analytical procedures required, Charlie Gower for discussions on the geology and mineral potential of the area, Terry Sears for his major contribution to preparation of the final figures, Wayne Tuttle for logistical support and

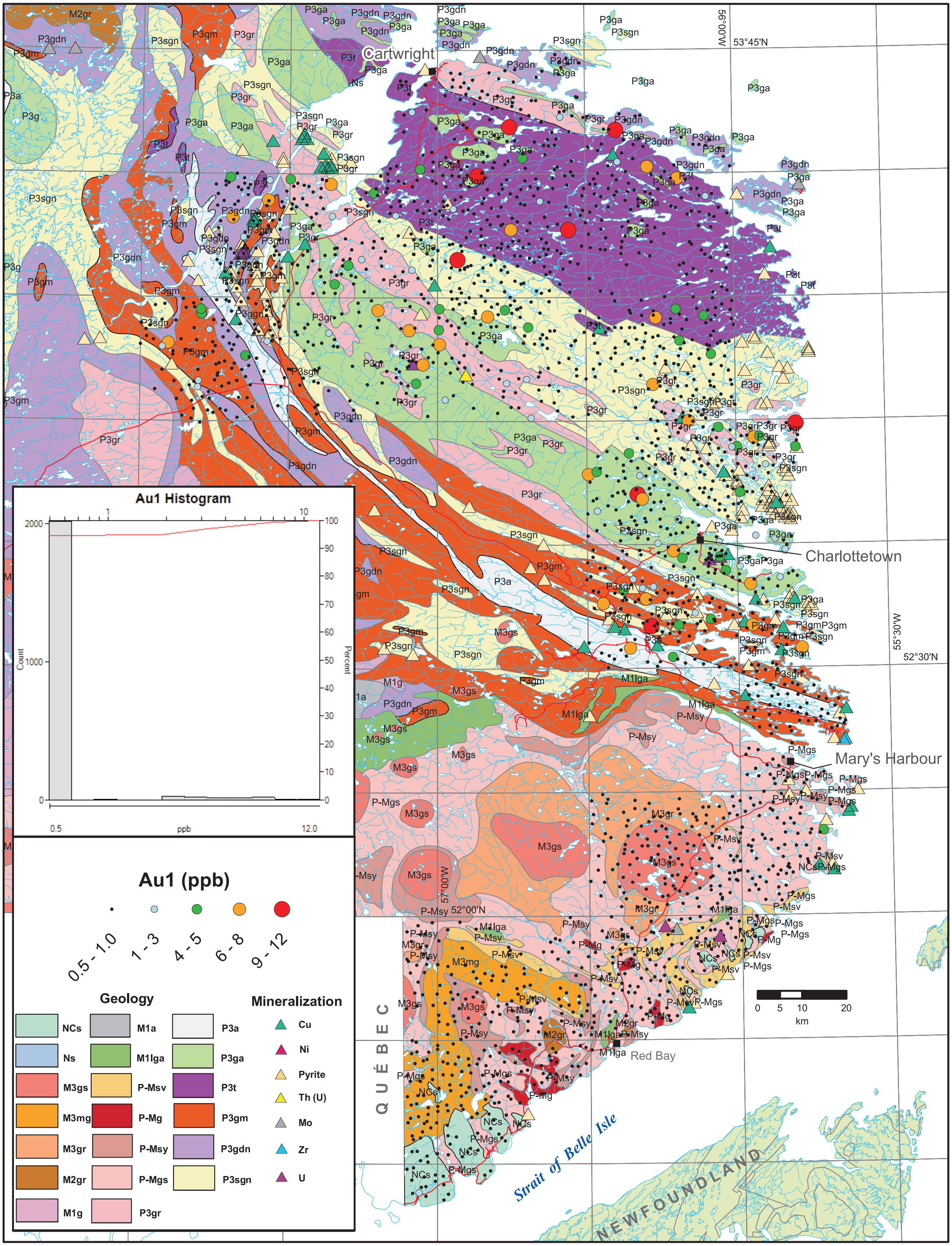

Figure 11. *Gold (Au1) in lake sediment.*

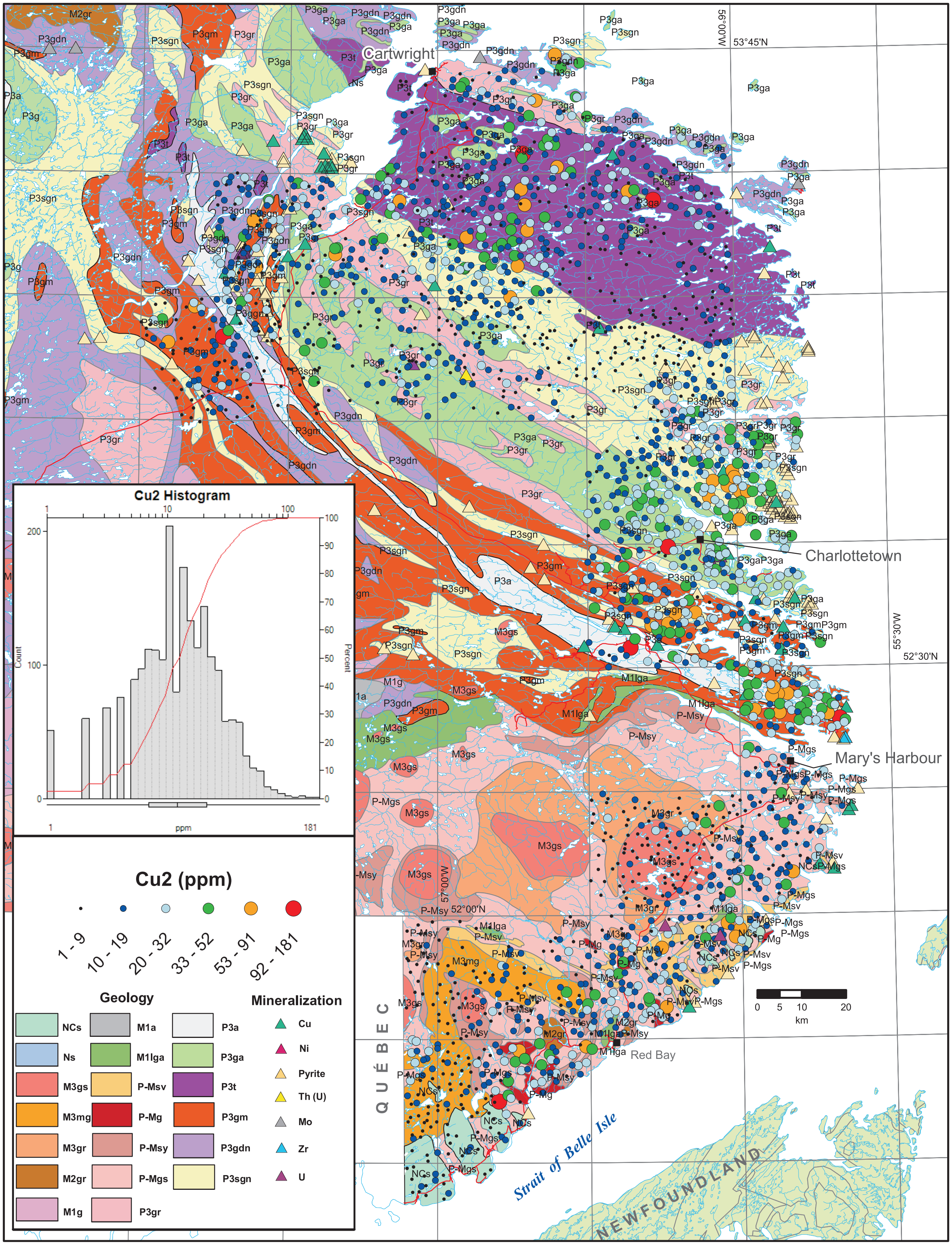

Figure 12. *Copper (Cu2) in lake sediment.*

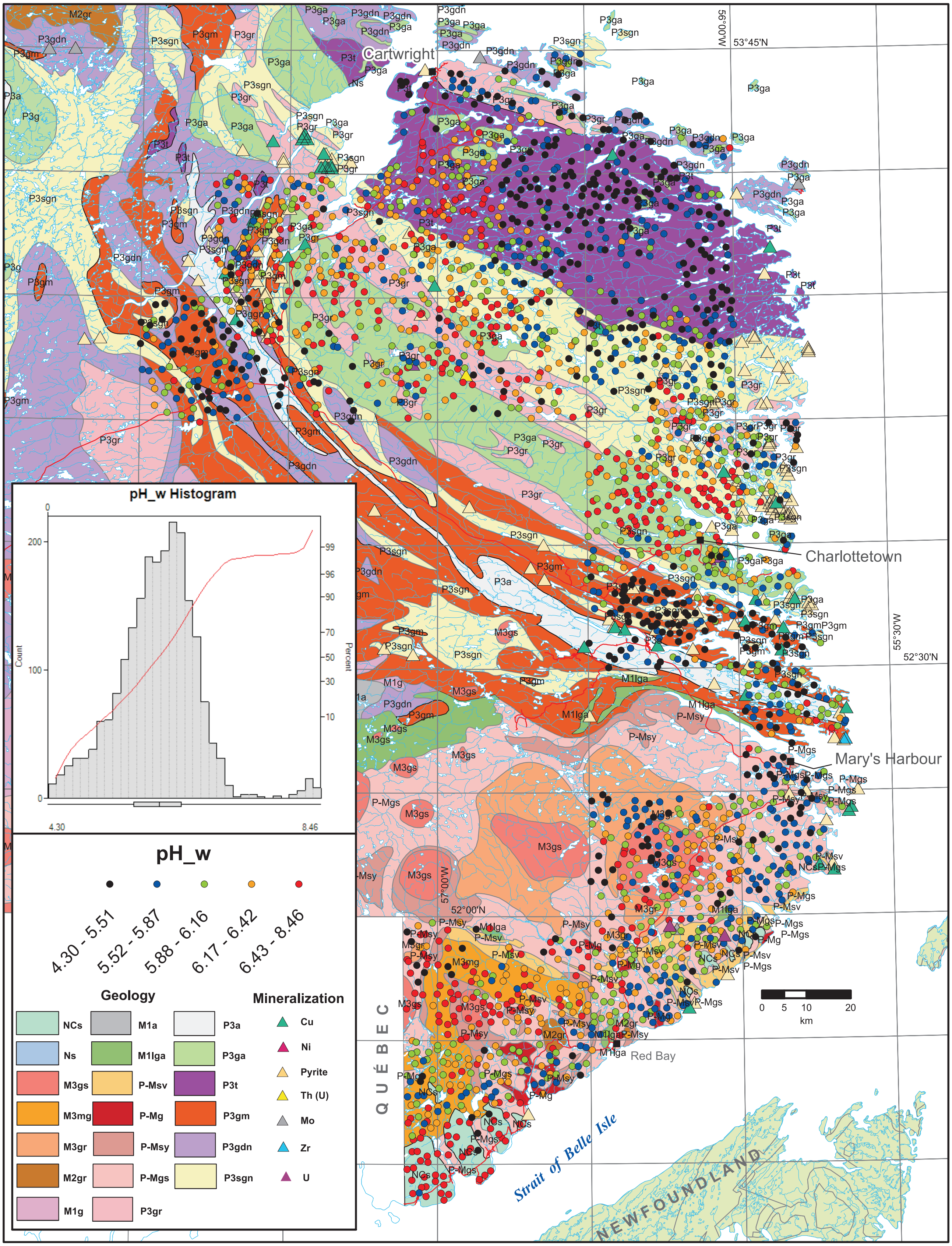

Figure 13. *Acidity (pH_w) of lake water.*

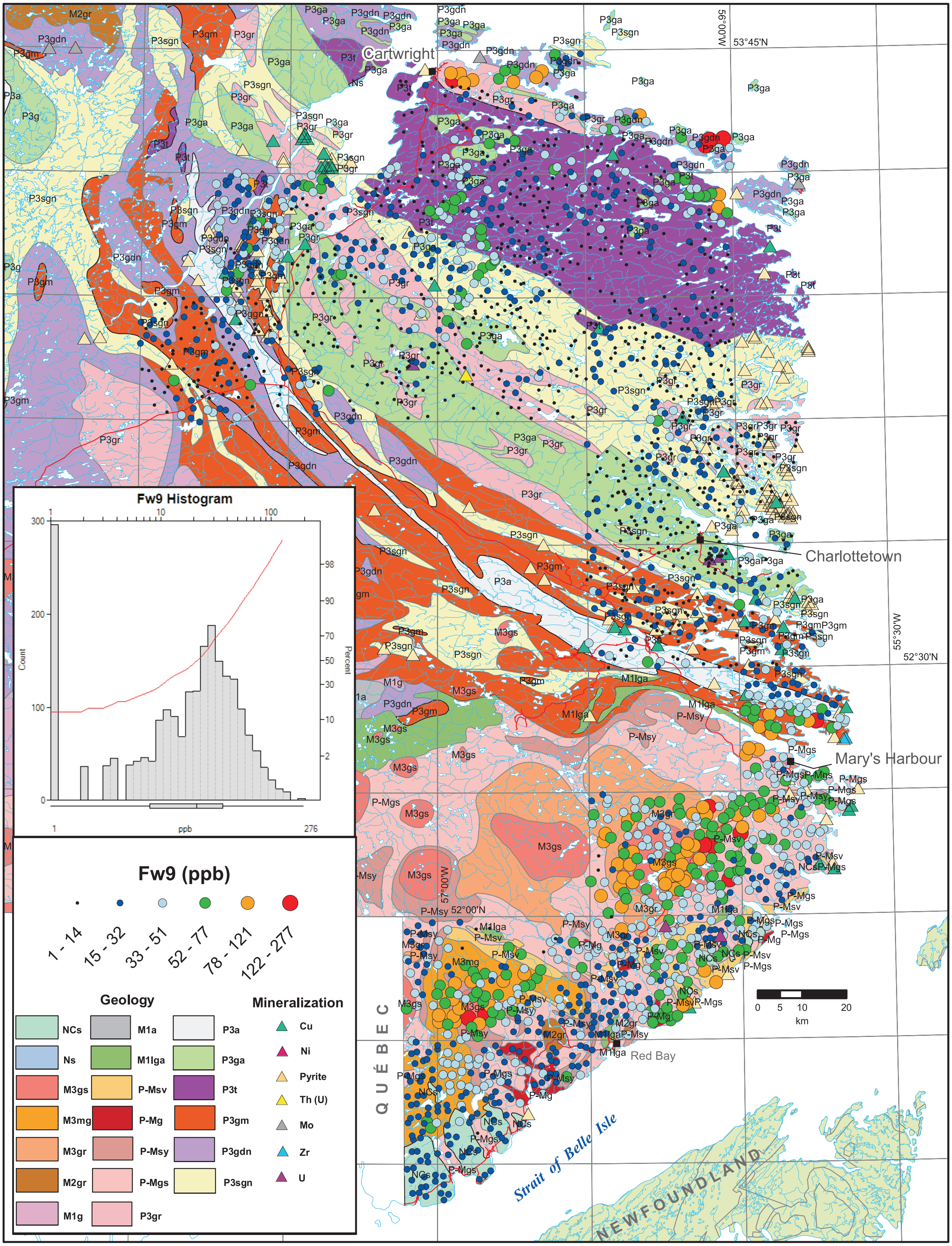

Figure 14. *Fluoride (Fw9) in lake water.*

Martin Batterson and Pauline Honarvar for their valuable contributions to the final draft of the manuscript.

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