INTRODUCTION



Figure 1. Location of the NTS sheets from which the lake sediments were originally collected and will be reanalyzed.

The study area covers over 45 000 km² within the National Topographic System (NTS) Map sheets 13K, 13J, 13I, 13N, and 13O (Figure 1). A batch of 4011 lake sediment samples was reanalyzed for additional elements not determined initially, with and at lower detection limits that provide an assessment of mineral potential not possible during the initial analysis.

The original samples, collected between 1977 and 1984, were amalgamated in 1993 (Table 1). These 4011 samples were retrieved from the GSC's archive, sieved to recover the silt fraction (< 180 μ m) and submitted to Bureau Veritas Laboratories in Vancouver for geochemical analysis. Lake sediment samples were digested using a modified aqua regia solution (1:1:1 HNO₃:HCI:H₂O) followed by inductively coupled plasma mass spectrometry (ICP-MS) with an additional package for rare earth elements (REE). Data for 65 elements will be determined with improved upper and lower detection limits.

Following the analysis of the archived material, the data will undergo GSC Quality Assurance and Quality Control protocols (QA/QC) to ensure the reliability of the data (high precision and accuracy) following the procedures of McCurdy and Garrett (2016) and using an Analysis of Variance (ANOVA) of duplicate samples.

Table 1.				
NTS Sheet	GSC Open Files	# samples	Last date of analysis	# elements
131	513, 1636, 2646	129	1993	8
13J	513, 1636, 1637,2646	992	1993	8
13K	997, 1636, 2645, 2650	1710	1993	9
130	1636, 1637, 2646	207	1993	8
13N	558, 1636, 2648	973	1993	34

Figure 2. Bedrock geology of Quebec and Labrador with the NTS map sheets (NTS 13I, 13J, 13K, 13N and 13O) from which lake sediments were originally collected. The study area largely falls within the Hopedale Block, which has some of the more complex geology of the region (modified from Hinchey et. al., 2022).

As part of the Geological Survey of Canada's (GSC) Geo-Mapping for Energy and Minerals (GEM) GeoNorth Program (2020-2027), a collection of archived lake sediment samples are being reanalyzed to assess mineral potential not examined during previous research programs (i.e., rare earth minerals (REEs)). This work augments the previous reanalysis of lake sediments from the Quebec and Labrador region (e.g., McCurdy et al., 2018). Additionally, the reanalysis with lower detection limits and increased analytical precision provides higher resolution data for the region. Therefore, a more detailed geochemical profile of the lake sediment composition can be achieved by providing insights unavailable during the original analyses.

This region is of specific interest due to its bedrock geology (Figure 2) and ample lake sediment coverage (Figure 3), whose reanalysis using modern analytical techniques will provide vital data for critical and other mineral potential. Unfortunately, a detailed geochemical understanding of the regional bedrock geology has been complicated by the widely dispersed Quaternary sediments that blanket most of the bedrock within the Hopedale region. However, localized ice streams have transported material significantly down-ice and have been shown to disperse indicators of economic deposits (e.g., Strange Lake (Fig. 3d); McClenaghan et al., 2019).

Once completed, this map will represent Canada's largest contiguous geochemical map and provide a broad geochemical understanding of the region, which can be the foundation of future surficial mapping and mineral exploration exercises planned for GEM GeoNorth programs around the Hopedale Region.

BEDROCK GEOLOGY



Natural Resources Ressources naturelles Canada Canada

GEOCHEMICAL REANALYSIS OF ARCHIVED REGIONAL LAKE-SEDIMENT SAMPLES FROM THE HOPEDALE BLOCK, NEWFOUNDLAND AND LABRADOR

M.W. McCurdy¹, R.C. Paulen¹, J.M. Rice¹, and H.E. Campbell²





Figure 3a-d. Lake sediments collected from sites in Quebec and Labrador between 1973 and 1997 and re-analyzed using ICP-MS for 53 elements (McCurdy et al., 2018). Results for a) Li, b) Cu, c) Ni, and d) Sn are shown above. Five colours represent the five ranges within analytical results from each site were classified. Data for the Hopedale region (black symbols) will be integrated with the adjacent data set from Quebec and Labrador.

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ELEMENT CONCENTRATION MAPS

This project is designed to create the most extensive contiguous geochemical map in that will reveal large-scale Canada geochemical patterns, assist in regional bedrock mapping, and guide mineral exploration in the region. Previous lake sediment geochemical reanalysis has shown that some bedrock lithologies, buried under Quaternary sediments, can be characterized by specific elemental associations. These associations in lake sediments were demonstrated by Amor et al. (2019), showing that anorthosites are low in many elements (As, Ba, Bi, Cr, Cs, Cu, Fe, Hg, K, Li, Mg, Mn, Ni, Pb, Rb, Se, Th, Tl, U, Zn, Zr) and high in only one (Na).

Interestingly, this work also indicated that regional ice streams (IS) had a detectable on the geochemical distribution effect (McClenaghan et al., 2019). Specifically, the glacial dispersal of sediments within the Kogaluk IS (Figures 3d and 4) can be mapped using lake sediment geochemical data, indicating that the ice-flow history of the region must also be considered when evaluating the distribution of elements within the study area. Given the number of active ice streams draining the Laurentide Ice Sheet's eastern margin during deglaciation (Margold et al., 2015), the impact on geochemical patterns could be significant. Additionally, the dispersal patterns identified through this work will provide important empirical checks on ice-flow reconstructions.

With an expanded suite of elements updated ice-flow chronology, this and research has the potential to define new exploration targets.

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DISCUSSION



Figure 4. Distribution of ice streams (IS) and major divides (AL= Ancestra Labrador, D= Quebec-Labardor Dome) for the Quebec/Labrador region (modified from Rice et al. 2020, with additional ice streams from Margold et al. 2015).

1 H Hydrogen 1.008	E	Elements originally analyzed during National Geochemical Reconnaissance (NGR) Program 1977- 1984													2 He Helium 4.003			
3 Lithium 6.94	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O 0xygen 15.999	9 F Fluorine 18.998	10 Ne 20.180	
11 Na sodium 22.990	12 Mg Magnesium 24.305	Actinide series **Actinide series + As the fluoride ion											13 Al Aluminum 26.982	14 Si ^{Silicon} 28.085	15 P Phosphorus 30.974	16 S ^{Sulfur} 32.06	17 CI ^{Chlorine} 35.45	18 Ar ^{Argon} 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078		21 Sc Scandium 44.956	22 Ti ^{Titanium} 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni _{Nickel} 58.693	29 Cu _{Copper} 63.546	30 Zn _{Zinc} 65.38	31 Gallium 69.723	32 Ge Germanium 72.630	33 As Arsenic 74.922	34 Se selenium 78.97	35 Br Bromine 79.904	36 Kr Krypton 83.798
Rubidium 85.468	38 Strontium 87.62		39 Y Yttrium 88.906	40 Zr ^{Zirconium} 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 TC Technetium [97]	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag _{Silver} 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn ^{Tin} 118.710	51 Sb Antimony 121.760	53 Te Tellurium 127.60	53 lodine 126.904	54 Xe _{Xenon} 131.293
55 CS Cesium 132.905	56 Ba Barium 137.327	* 57 - 70	71 Lu Lutetium 174.967	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W ^{Tungsten} 183.84	75 Re Rhenium 186.207	76 OS _{Osmium} 190.23	78 Ir Iridium 192.217	79 Pt Platinum 195.084	80 Au _{Gold} 196.997	81 Hg Mercury 200.592	81 TI Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Polonium [209]	85 At Astatine [210]	86 Rn _{Radon} [222]
87 Fr Francium [223]	88 Ra Radium [226]	* * 89 - 102	103 Lr Lawrencium [262]	104 Rf Rutherfordium [267]	105 Db _{Dubnium} [270]	106 Sg Seaborgium [269]	107 Bh Bohrium [270]	108 HS _{Hassium} [270]	109 Mt Meitnerium [278]	110 DS Darmstadtium [281]	111 Rg Roentgenium [281]	112 Cn Copernicium [285]	113 Nh _{Nihonium} [286]	114 Fl Flerovium [289]	115 MC Moscovium [289]	116 Lv Livermorium [293]	117 TS Tennessine [293]	118 Og Oganesson [294]
		57 La Lanthanum 138 905	58 Ce 140 116	59 Pr Praseodymium 140,908	60 Nd Neodymium 144 242	61 Pm Promethium [145]	62 Sm Samarium 150.36	63 Eu Europium 151 964	64 Gd Gadolinium 157 25	65 Tb Terbium 158,925	66 Dy Dysprosium 162 500	67 HO Holmium 164 930	68 Er Erbium 167,259	69 Tm 168,934	70 Yb Ytterbium 173 045			
1 H Hydrogen		89 Actinium [227]	90 Th Thorium 232.038	91 Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium [237]	94 Pu Plutonium [244]	95 Am Americium [243]	96 Cm _{Curium} [247]	97 Bk Berkelium [247]	98 Cf ^{Californium} [251]	99 Es Einsteinium [252]	100 Fm Fermium [257]	101 Md Mendelevium [258]	102 No Nobelium [259]			2 He Helium
1.008 3 Lithium 6,94	4 Be Beryllium 9.012	Elements being analyzed in this study (2022)												9 F Fluorine 18.998	10 Ne 20,180			
11 Na Sodium 22.990	12 Mg Magnesium 24.305	*Lanthanide series **Actinide series										13 Aluminum 26.982	14 Si ^{Silicon} 28.085	15 P Phosphorus 30.974	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.948	
19 K Potassium 39.098	20 Ca Calcium 40.078		21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 CO _{Cobalt} 58.933	28 Ni _{Nickel} 58.693	29 Cu _{Copper} 63.546	30 Zn _{Zinc} 65.38	31 Gal 69.723	32 Gee Germanium 72.630	33 AS Arsenic 74.922	34 Se selenium 78.97	35 Br ^{Bromine} 79.904	36 Kr _{Krypton} 83.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62		39 Y Yttrium 88.906	40 Zr ^{Zirconium} 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 TC Technetium [97]	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag _{Silver} 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn ^{Tin} 118.710	51 Sb Antimony 121.760	53 Te Tellurium 127.60	53 lodine 126.904	54 Xe _{Xenon} 131.293
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87 Fr Francium [223]	88 Ra Radium [226]	* * 89 - 102	103 Lr Lawrencium [262]	104 Rf Rutherfordium [267]	105 Db Dubnium [270]	106 Sg _{Seaborgium} [269]	107 Bh Bohrium [270]	108 HS Hassium [270]	109 Mt Meitnerium [278]	110 DS Darmstadtium [281]	111 Rg Roentgenium [281]	112 Cn Copernicium [285]	113 Nh _{Nihonium} [286]	114 Fl Flerovium [289]	115 Mc Moscovium [289]	116 Lv Livermorium [293]	117 TS Tennessine [293]	118 Og Oganesson [294]
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reanalysis of archived regional lake**-s**ediment samples from the Hopedale Block

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