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DIGITAL GEOSCIENCE ATLAS OF LABRADOR

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ABSTRACT

The digital geoscience atlas of Labrador provides, on a single CD-ROM, complete regional coverage for Labrador of the bedrock and surficial geology, drainage, geochemistry and potential-field geophysics, together with a database of mineral occurrences, and a topographic base and NTS grid. The various "information layers" have been designed to take full advantage of the capabilities of the commonly used desk top GIS systems Arcview 3 *and* Mapinfo 4. *The data and their organization are described in a set of help files.*

INTRODUCTION

The CD-ROM version of the 1:1 000 000-scale geological map of Labrador (Wardle *et al.*, 1997) provides a digital frame of reference for the Geoscience database that has been built up methodically for the region over the past 25 years. In addition to the bedrock geology database, Labrador is completely covered by regional geophysical (aeromagnetic and gravity) surveys, regional geochemical (lake- and stream-sediment and water) surveys, reconnaissance surficial geology, and a mineral occurrence database (MODS). Although useful individually, when brought together as a digital atlas designed around commonly used desktop GIS systems, they provide a comprehensive overview of the geoscience knowledge base for Labrador that can be applied in mineral exploration planning, mineral resource appraisal, environmental baseline studies and land-use planning. The digital atlas also provides a multiparameter, contextual framework within which other more detailed, but geographically restricted, geoscience surveys can be placed.

GEOSCIENCE DATA LAYERS

BEDROCK GEOLOGY

The bedrock geology layer (Figure 1) is taken from the Digital Geological Map of Labrador (Wardle *et al.*, 1997). The digital map has seven components:

1. Geological units as polygons (GEOLOGY)
2. Geological contacts as lines (CONTACTS)
3. Geological faults as lines (FAULTS)
4. Shear zones as polygons (SHEARP)
5. Shear zones as lines (SHEARL)
6. Tectonic provinces as polygons (TECTP)
7. Limits of post-1970 mapping (MAPLIMIT)

These components are organized to take advantage of the capabilities of the viewers to display information, and although no changes have been made to the map units, some of the attribute tables have been reorganized. The geological unit polygons (GEOLOGY) contain the attributes listed in Table 1. Geological contacts, i.e. polygon outlines, are also included as lines (GEOLOGYL) having three pairs of attribute fields; ROCKCL_L and ROCKCL_R (the values for ROCKCLASS, Table 1, to the left and right of the line segment), AGE_L and AGE_R (the values for AGE_DIVISI, Table 1, to the left and right of the line segment), and TECT_L and TECT_R (the values for TECTONIC_P, Table 1, to the left and right of the line segment). These fields can be used through viewer queries to remove internal boundaries between map units that are generalized by rock classification, geological age or tectonic province, respectively.

Faults (FAULTS) may or may not form polygon boundaries, and constitute a separate line layer having two attribute fields; TYPE with four valid categories: fault, normal fault, thrust fault and transcurrent fault and QUALIFIER, which may take the values major, minor or reactivated. Shear zones are treated in two ways; individual shears are included as lines (SHEARL), and major zones of shears have been placed in a separate category as polygons (SHEARP).

[1] Mineral Deposits Section

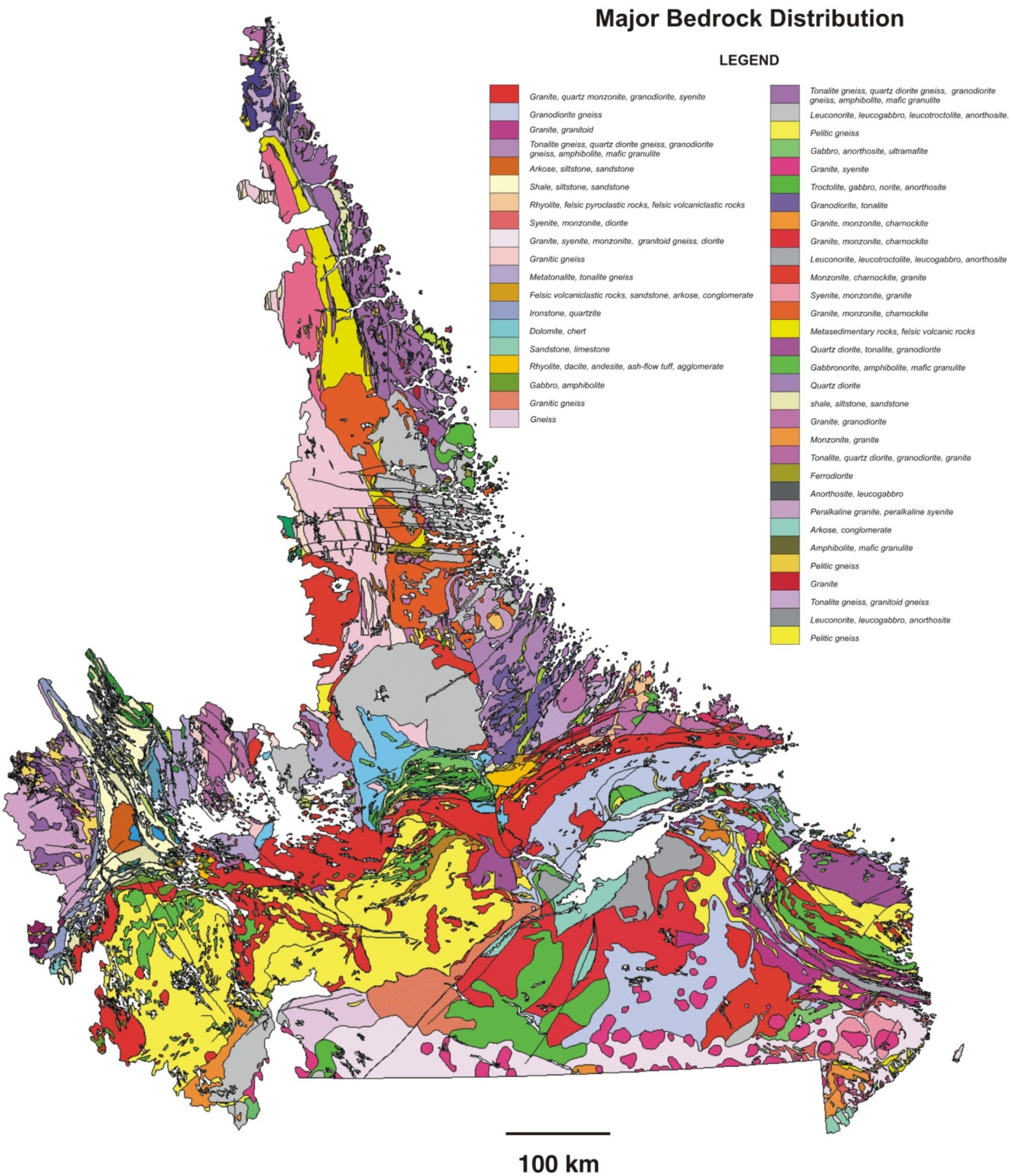

Figure 1. *Bedrock geology of Labrador, units classified by major rock type (from Wardle* et al., *1997).*

Table 1. Variables included in geological polygon attribute set

1.	UNITCODE	Map unit label
2.	UNIT_NAME	Name of Geological Unit
3.	ROCKTYPE	Major rock types in unit
4.	MINROCKTYPE	Minor rock types in unit
5.	ROCKCLASS	Rock classification
		PLUTONIC
		METAMORPHIC
		STRATIFIED
6.	AGE_DIVISI	Geological age
		Archean and/or Paleoproterozoic
		Early Mesoproterozoic
		Early Paleoproterozoic
		Eo-Paleoarchean
		Late Mesoproterozoic
		Late Paleoproterozoic
		Mesoarchean
		Mid Mesoproterozoic
		Mid Paleoproterozoic
		Neoarchean
		Neoproterozoic
		Neoproterozoic - Cambrian
		Paleo and/or Mesoproterozoic
		Tertiary
		Undivided Archean
7.	TECTONIC_P	Tectonic Province
		GP - Grenville Province
		MP - Makkovik Province
		NP - Nain Province
		CP - Churchill Province
		SP - Superior Province
10.	AGE_DATING	Absolute (Radiometric) age, millions of years (text field)
11.	DESCRIPTION	Description of map unit (from legend of Map 97-07)
12.	AREA	Area of each mapped unit (km^2)
13.	RED	Map unit Colour, RGB scheme, red
14.	GREEN	Map unit Colour, RGB scheme, green
15.	BLUE	Map unit Colour, RGB scheme, blue

The major tectonic divisions of Labrador are presented as a polygon coverage (TECTP). Tectonic province boundaries are projected through posttectonic intrusions and sedimentary cover using geophysical and other evidence. The limits of poorly mapped areas (pre-1970 reconnaissance-scale mapping only) are contained as lines in MAPLIMIT.

SURFICIAL GEOLOGY

The surficial geology layer (Figure 2) is taken from the 1:1 000 000-scale map of glacial landforms and deposits by Klassen *et al*. (1992). Glacial deposits are subdivided into a simple seven-fold classification (attribute field GENETIC); "ablation drift", "drift poor", "glaciofluvial", "glaciolacustrine", "glaciomarine and marine", "rogen moraine", and "till, undifferentiated". Surficial deposit units are presented in the atlas as polygons (SURFPOLY), some of which are so large that they have been internally subdivided because of limitations of the viewer software. The areas of the polygons (in km^2) are given in the field AREA, as well as RGB colours in the fields Red, Green and Blue. The complete unit boundaries have been included as lines (SURFLINE).

MINERAL OCCURRENCES

The information on mineral occurrences (Figure 3) from the MODS/PC database (Stapleton and Parsons, 1996) is presented in an abbreviated form as a point layer. The attributes for each occurrence are listed in Table 2.

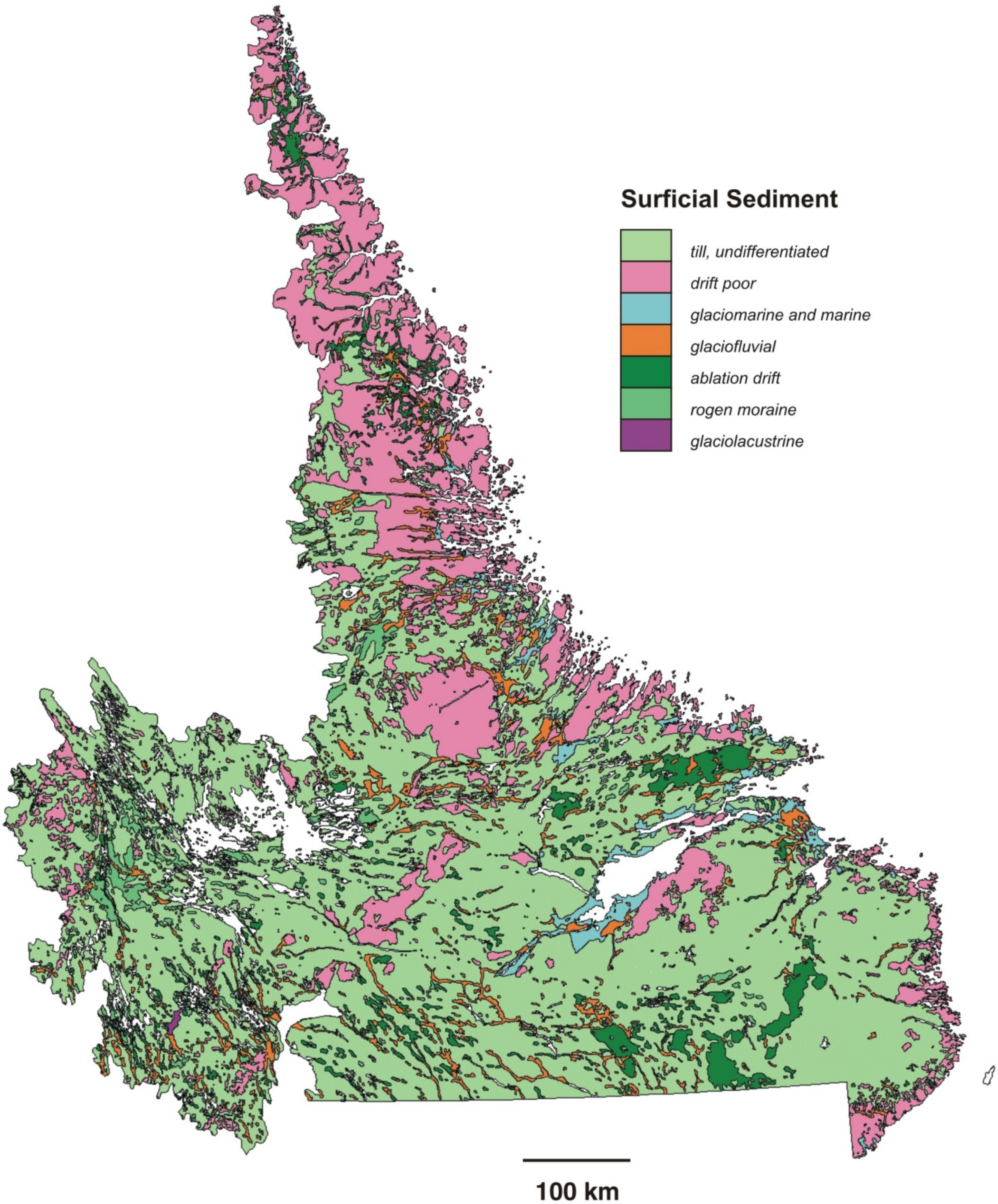

Figure 2. *Surficial geology of Labrador, units classified by depositional style (from Klassen* et al.*, 1992).*

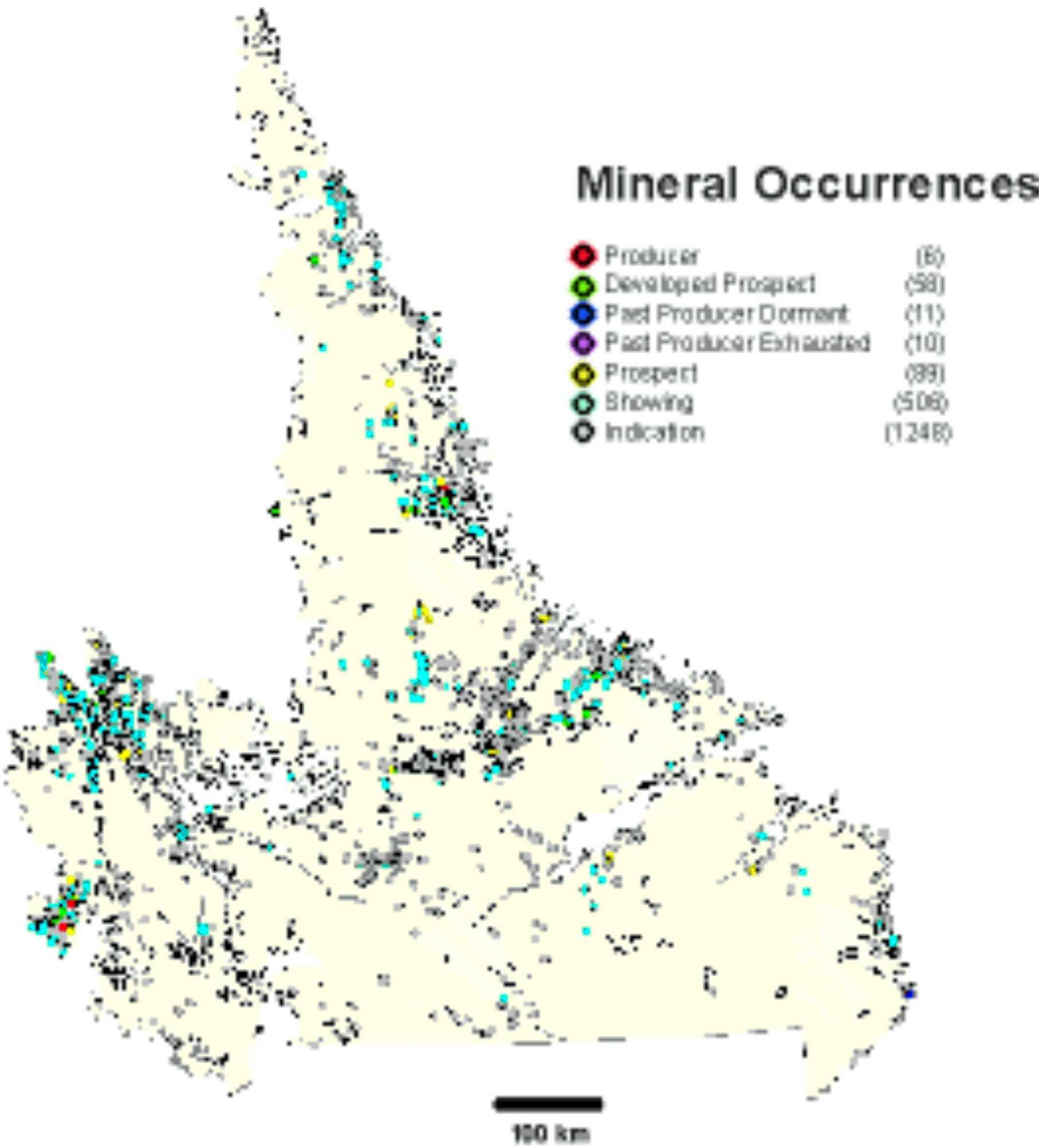

Figure 3. *Mineral occurrences of Labrador, classified by development status.*

GEOCHEMISTRY

The geochemical data (Figure 4) for most of the region (south of latitude 58°30'N) are based on systematic lake-sediment and water surveys (Friske *et al.,* 1992a,b; 1993a to j; 1994a to e), although stream-sediment and water were the sample media north of latitude 58°N in the Torngat Mountains (Friske *et al.*, 1994f), where lakes are few and irregularly distributed. The data were first released as a series of open files under the National Geochemical Reconnaissance (NGR) program (Friske and Hornbrook, 1991).

The parameters included in the geochemical data sets are listed in Tables 3 (lakes) and 4 (streams). Lake and stream data are not directly comparable for most parameters (Davenport, 1990) and are therefore treated separately in the digital atlas, where each type has been prepared for display in the following formats.

Table 2. Variables in mineral occurrence attribute set

1.	DEP_NAME	Deposit Name: the most commonly accepted deposit name found in the literature.
2.	ALT_NAME	Secondary name, if deposit or occurrence has been known by some other name.
3.	NMINO	National Mineral Inventory Number consists of three parts separated by slashes. The first two parts place the deposit in the NTS grid. The third identifies the major commodity, e.g., NMINO = 012b/08/Gyp001.
4.	MAJOR_COM	Major Commodity (full name) present in the deposit, eg. copper, zinc, granite.
5.	MOD_TYPE	Major Commodity (abbreviation) present in the deposit, eg. Cu, Zn, stn.
6.	MINOR_COM	Field contains all secondary commodities (as abbreviations) present in the deposit.
7.	DEP_TYPE	Deposit Type; coded genetic classification of mineral deposits.
8-11.	DEP_CHAR	Deposit Character (4 fields) describes deposit attributes, such as morphology of the mineralization and the host rocks in which it occurs (e.g., disseminated sulphides in mafic volcanics); metamorphism, alteration of the wall-rock, deposit shape, age of mineralization, etc.
12-13.	STATUS	Indicator of amount of work done and hence the amount of information available on a deposit: STATUS, numeric code; STATUS_KEY, label. 1. Producer - Commodity is extracted for sale 2. Developed Prospect - Reserves or demonstrated resources of the commodity can be calculated but the commodity has not yet been produced (i.e., three dimensional data plus grade). 3. Past Producer Dormant - the commodity is no longer produced, although there are known reserves or demonstrated resources. 4. Past Producer Exhausted - the commodity is no longer produced and there are no longer reserves or demonstrated resources. 5. Prospect - two dimensional data and grade are available but not enough data to calculate reserves. 6. Showing - One dimensional data and grade 7. Indication - an indication of the existence of the commodity. ie. field observation, assay, etc.
14.	GEOLOGY	Geological unit in which occurrence lies; codes from field UNIT-CODE from 1:1,000,000 bedrock geology layer
15.	HOST_ROCK	Individual rock types associated with the deposit, e.g. anorthosite, paragneiss, shale, etc.
16.	STRUNIT	Stratigraphic Unit refers to the geological name of the unit in which the deposit occurs.
17.	GEOLWK	If Geological Work done on the area around the mineral deposit, field contains a 'Y' (does not count regional studies).
18.	GEOPHWK	If Geophysical Work done on the area around the mineral deposit, field contains a 'Y' (does not count regional studies).
19.	GEOCHWK	If Geochemical Work done on the area around the mineral deposit, field contains a 'Y' (does not count regional studies).
20.	DDH	The number of drillholes into the deposit; 0 means that the deposit has been drilled but the number of holes is unknown. A value of -9 indicates that the deposit has not been drilled.
21.	WORKING	Type of mine workings. This field would have a value for deposits of status 1, 3 or 4. Underground - u Open Pit or Quarry - o Strip - s Placer - p Solution/Leaching - l Underground and Open Pit - uo Underground and Strip - us Underground and Placer - up Uncertain - un
22-23.	PRORES	Production and Reserves (2 fields); records of production per day or per year and reserves (using the McKelvey classification, i.e., Measured, Indicated, inferred). Example: PROD - 8,000 tonnes (per day) of 3% Cu, 5% Zn; Res - (indicated) of 2,000,000 tonnes
24.	Utmzone	UTM Zone
25.	Utmeast	UTM easting, m
26.	Utmnorth	UTM northing, m

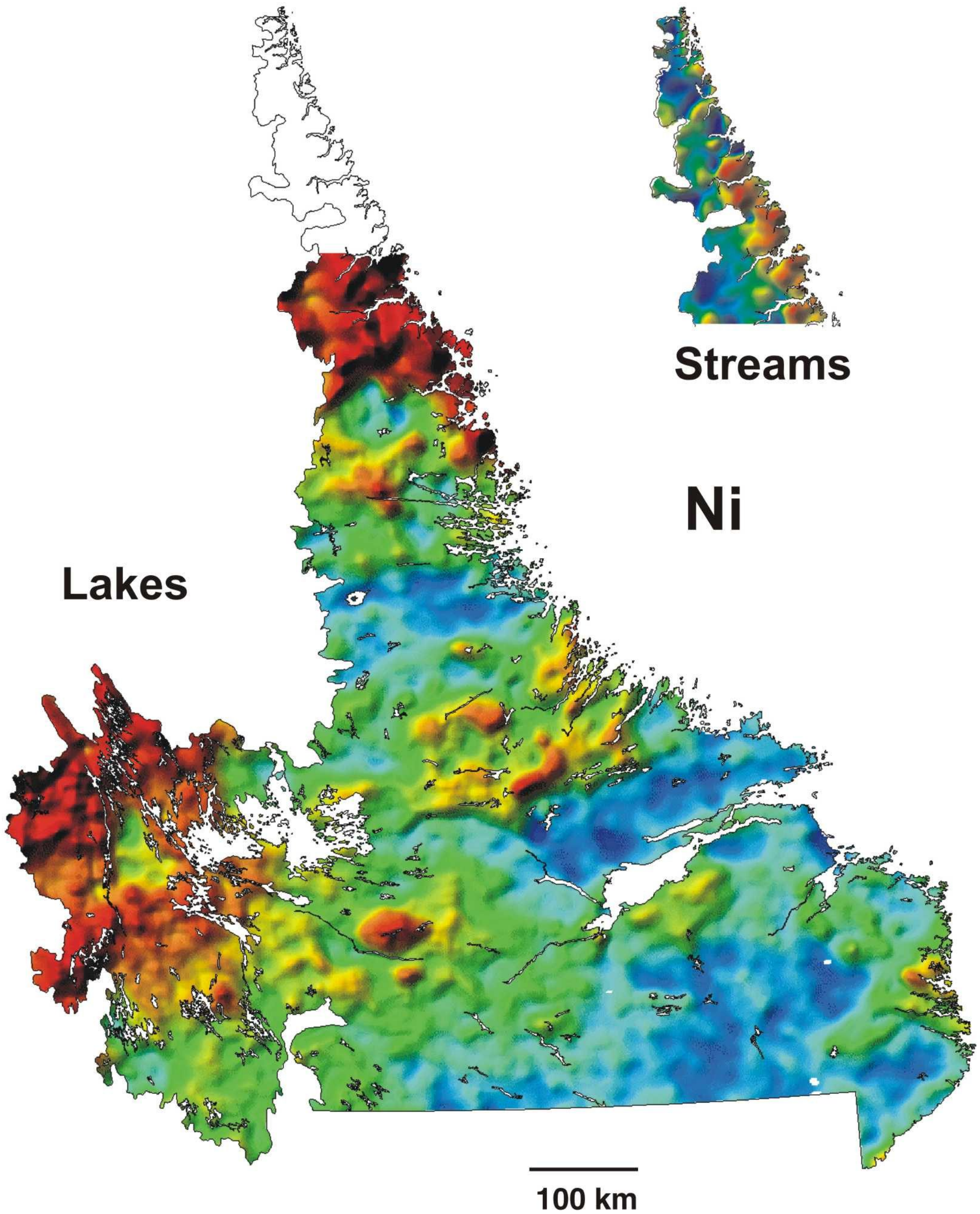

Figure 4. *Shaded-relief, colour image of the interpolated distribution of nickel from regional geochemical surveys in Labrador.*

1) *Interpolated geochemical surfaces as colour raster images, with and without shading,* which are useful for displaying broad, qualitative variations in the geochemical background of individual elements (Figure 4, shaded from the northwest, and Figure 5, unshaded).

2) *Interpolated geochemical surfaces as line contours* at the 5th, 10th, 15th, 20th, 25th, 30th, 35th, 40th, 45th, 50th, 55th, 60th, 65th, 70th, 75th, 80th, 85th, 90th, 95th and 98th percentiles, labeled in concentration units. The complete set of contours can be displayed, or specific levels can be selected. This format is useful for displaying broad, quantitative variations in the geochemical background of individual elements (Figure 6), and can be placed over raster images or coloured thematic information such as bedrock geology. Because the contours are quantitative, they are prepared only for elements whose

Table 3. Variables included in lake geochemical dataset

1.	Sample ID	
2.	nts	NTS sheet (1:50 000)
LAKE SEDIMENT		
3.	Ag3_ppm	Silver, ppm, by FAAS
4.	As1_ppm	Arsenic, ppm, by INAA
5.	As19_ppm	Arsenic, ppm, by HAAS
6.	As21_ppm	Arsenic, ppm, by COL
7.	Au1_ppb	Gold, ppb, by INAA
8.	Ba1_ppm	Barium, ppm, by INAA
9.	Br1_ppm	Bromine, ppm, by INAA
10.	Cd3_ppm	Cadmium, ppm, by FAAS
11.	Ce1_ppm	Cerium, ppm, by INAA
12.	Co1_ppm	Cobalt, ppm, by INAA
13.	Co3_ppm	Cobalt, ppm, by FAAS
14.	Cr1_ppm	Chromium, ppm, by INAA
15.	Cs1_ppm	Cesium, ppm, by INAA
16.	Cu3_ppm	Copper, ppm, by FAAS
17.	Eu1_ppm	Europium, ppm, by INAA
18.	F9_ppm	Fluorine, ppm, by PA
19.	Fe1_pct	Iron, %, by INAA
20.	Fe3_pct	Iron, %, by FAAS
21.	Hf1_ppm	Hafnium, ppm, by INAA
22.	Hg18_ppb	Mercury, ppb, by CVAAS
23.	La1_ppm	Lanthanum, ppm, by INAA
24.	Lu1_ppm	Lutetium, ppm, by INAA
25.	Mn3_ppm	Manganese, ppm, by FAAS
26.	Mo1_ppm	Molybdenum, ppm, by INAA
27.	Mo5_ppm	Molybdenum, ppm, by FAAS
28.	Na1_pct	Sodium, %, by INAA
29.	Ni1_ppm	Nickel, ppm, by INAA
30.	Ni3_ppm	Nickel, ppm, by FAAS
31.	Pb3_ppm	Lead, ppm, by FAAS
32.	Rb1_ppm	Rubidium, ppm, by INAA
33.	Sb1_ppm	Antimony, ppm, by INAA
34.	Sc1_ppm	Scandium, ppm, by INAA
35.	Sm1_ppm	Samarium, ppm, by INAA
36.	Ta1_ppm	Tantalum, ppm, by INAA
38.	Tb1_ppm	Terbium, ppm, by INAA
39.	Th1_ppm	Thorium, ppm, by INAA
40.	U1_ppm	Uranium, ppm, by INAA
41.	U8_ppm	Uranium, ppm, by NANC
42.	V5_ppm	Vanadium, ppm, by FAAS
43.	W1_ppm	Tungsten, ppm, by INAA
44.	Yb1_ppm	Ytterbium, ppm, by INAA
45.	Zn3_ppm	Zinc, ppm, by FAAS
46.	LOI_pct	Loss-on-ignition, %, GA
47.	INAAWT_g	Sample weight (g) used for INAA
LAKE WATER		
48.	Fw9_ppb	Fluorine, ppb, by PA
50.	pHw	pH (hydrogen ion activity) by PA
51.	Uw10_ppb	Uranium, ppb, by LIF
52.	Uw11_ppb	Uranium, ppb, by FTA
SITE DESCRIPTORS		
53.	Year	Year of sample collection
54.	UTMZone	UTM Zone
55.	Utmeast	UTM easting, m
56.	Utmnorth	UTM northing, m
57.	Depth_m	Lake depth, m, at sample site
58.	Lakesize	Lake area
59.	Colour	Sediment colour
60.	Contamin	Site contamination; 0 - absent; 1 - present
61.	Openfile1	Original open file number
62.	Openfile2	Latest open file number

KEY

COL	Colorimetry
CVAAS	Cold-Vapour atomic absorption spectrophotometry
FAAS	Flame atomic absorption spectrophotometry
FTA	Fission track analysis
GA	Gravimetric analysis
HAAS	Hydride atomic absorption spectrophotometry
INAA	Instrumental Neutron Activation Analysis
LIF	Laser induced fluorescence
NANC	Neutron Activation, delayed Neutron Counting
PA	Potentiometric analysis

between-site variance is greater than 3 times the combined sampling and analytical variance as determined from site duplicates (Garrett, 1973). Details of the analysis of variance and interpolation methods used to produce both the contours and colour images of the geochemical data are given in the atlas documentation.

3) *Individual sites* that the viewer can symbolize and classify in a variety of user-defined ways using the data contained in the attribute tables (Tables 3 and 4). There are 18 640 lake sites, and 1244 stream sites (Figure 7). Site data are most useful at more detailed scales.

GEOPHYSICS

The regional aeromagnetic- and gravity-survey data for Labrador are presented as interpolated shaded-relief images (raster format) (Figures 8 and 9). The aeromagnetic data are included at two resolutions; a single image based on an 800-m-square grid, and a higher resolution image based on a

Table 4. Variables included in stream geochemical dataset

1.	Sample ID	
2.	nts	NTS sheet (1:50 000)
STREAM SEDIMENT CHEMISTRY		
3.	Ag4_ppm	Silver, ppm, by FAAS
4.	As1_ppm	Arsenic, ppm, by INAA
5.	As19_ppm	Arsenic, ppm, by HAAS
6.	Au1_ppb	Gold, ppb, by INAA
7.	Au16_ppb	Gold, ppb, by Fire Assay, INAA
8.	Ba1_ppm	Barium, ppm, by INAA
9.	Ba20_ppm	Barium, ppm, by FAAS
10.	Br1_ppm	Bromine, ppm, by INAA
11.	Cd4_ppm	Cadmium, ppm, by FAAS
12.	Ce1_ppm	Cerium, ppm, by INAA
13.	Co1_ppm	Cobalt, ppm, by INAA
14.	Co4_ppm	Cobalt, ppm, by FAAS
15.	Cr1_ppm	Chromium, ppm, by INAA
16.	Cs1_ppm	Cesium, ppm, by INAA
17.	Cu4_ppm	Copper, ppm, by FAAS
18.	Eu1_ppm	Europium, ppm, by INAA
19.	F9_ppm	Fluorine, ppm, by PA
20.	Fe1_pct	Iron, %, by INAA
21.	Fe4_pct	Iron, %, by FAAS
22.	Hf1_ppm	Hafnium, ppm, by INAA
23.	Hg18_ppb	Mercury, ppb, by CVAAS
24.	La1_ppm	Lanthanum, ppm, by INAA
25.	Lu1_ppm	Lutetium, ppm, by INAA
26.	Mn4_ppm	Manganese, ppm, by FAAS
27.	Mo1_ppm	Molybdenum, ppm, by INAA
28.	Mo5_ppm	Molybdenum, ppm, by FAAS
29.	Na1_pct	Sodium, %, by INAA
30.	Ni1_ppm	Nickel, ppm, by INAA
31.	Ni4_ppm	Nickel, ppm, by FAAS
32.	Pb4_ppm	Lead, ppm, by FAAS
33.	Rb1_ppm	Rubidium, ppm, by INAA
34.	Sb1_ppm	Antimony, ppm, by INAA
35.	Sb19_ppm	Antimony, ppm, by HAAS
36.	Sc1_ppm	Scandium, ppm, by INAA
37.	Sm1_ppm	Samarium, ppm, by INAA
38.	Sn12_ppm	Tin, ppm, by SEAAS
39.	Ta1_ppm	Tantalum, ppm, by INAA
40.	Tb1_ppm	Terbium, ppm, by INAA
41.	Th1_ppm	Thorium, ppm, by INAA
42.	U1_ppm	Uranium, ppm, by INAA
43.	U8_ppm	Uranium, ppm, by NANC
44.	V5_ppm	Vanadium, ppm, by FAAS
45.	W1_ppm	Tungsten, ppm, by INAA
46.	W13_ppm	Tungsten, ppm, by COL
47.	Yb1_ppm	Ytterbium, ppm, by INAA
48.	Zn4_ppm	Zinc, ppm, by FAAS
49.	LOI_pct	Loss-on-ignition, %, GA
STREAM WATER CHEMISTRY		
50.	Fw9_ppb	Fluorine, ppb, by PA
51.	pHw	pH (hydrogen ion activity) by PA
52.	Uw10_ppb	Uranium, ppb, by LIF
PHYSICAL AND SITE PROPERTIES		
53.	SAND_PCT	Proportion of sand (>0.125mm)
54.	FINES_PCT	Proportion of fines (<0.125mm)
54.	ORGS_PCT	Proportion of organics (<0.125mm)
55.	Width_cm	Stream width (cm)
56.	Depth_cm	Stream depth (cm)
57.	Year	Year of sample collection
58.	UTMZone	UTM Zone
59.	Utmeast	UTM easting, m
60.	Utmnorth	UTM northing, m
61.	Samptype	Sample type
62.	Contam	Site contamination
63.	Banktype	Bank material at sample site
64.	H2OColor	Water colour
65.	Flowrate	Stream water flow rate
66.	SedColor	Sediment colour
67.	Sed_precip	Colour of any pebbles coatings
68.	Bank_stain	Colour of any rock staining near site
69.	Physiography	General physiography of drainage basin
70.	Drainage	Drainage pattern
71.	Stream_type	Stream type
72.	Stream_order	Stream order
73.	Stream_source	Source of water
74.	INAAWT_g	Sample weight (g) used for INAA
75.	FA_WT_g	Sample weight (g) used for Fire Assay, INAA

KEY

COL	Colorimetry
CVAAS	Cold-vapour atomic absorption spectrophotometry
FAAS	Flame atomic absorption spectrophotometry
FTA	Fission track analysis
GA	Gravimetric analysis
HAAS	Hydride atomic absorption spectrophotometry
INAA	Instrumental neutron activation analysis
LIF	Laser induced fluorescence
NANC	Neutron activation, delayed neutron counting
PA	Potentiometric analysis
SEAAS	Solvent-extraction, atomic absorption spectrophotometry

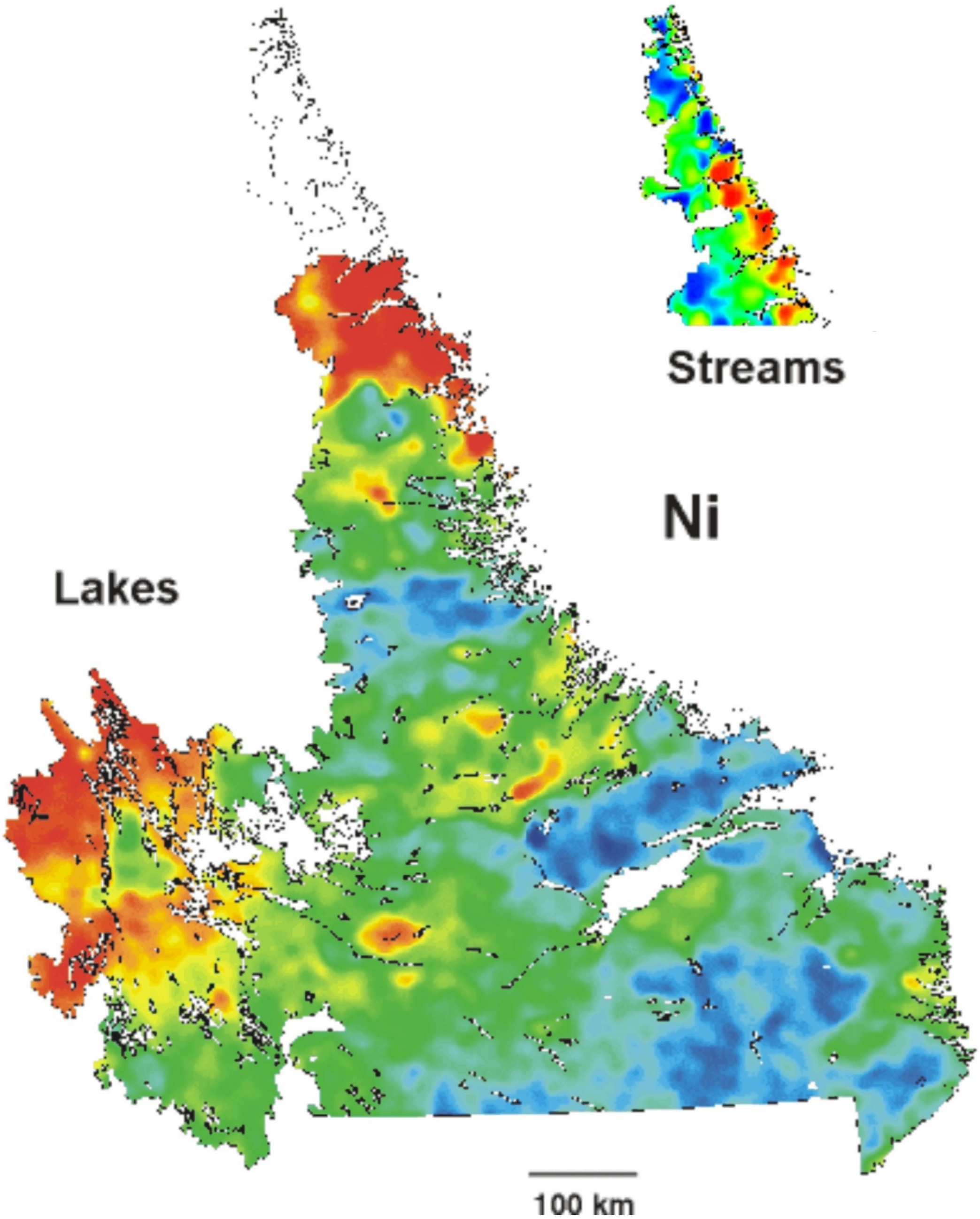

Figure 5. *Unshaded colour image of the interpolated distribution of nickel from regional geochemical surveys in Labrador.*

200-m-square grid, which because of its size is broken into several parts. Both images were produced from profile data from the National aeromagnetic database at the Geophysical Data Centre, Geological Survey of Canada, Ottawa, as described by Kilfoil and Bruce (1990, 1994). The gravity data, from the National gravity database, Geophysical Data Centre, were interpolated to a 1000-m-square grid, and transformed to a shaded-relief image (Kilfoil and Bruce, 1994). Both the gravity and aeromagnetic images are shaded from the north.

TOPOGRAPHIC REFERENCE DATA

The topographic base-map information is taken from the 1:1 000 000-scale International Map of the World series. The digital data were obtained from the Crown Lands Branch, Newfoundland Department of Government Services and Lands. The drainage network is contained in two layers: RIVERS, having a single field SIZE, which has the values SMALL, MEDIUM, LARGE and CANAL; and LAKES, having a single attribute field SIZE, which gives

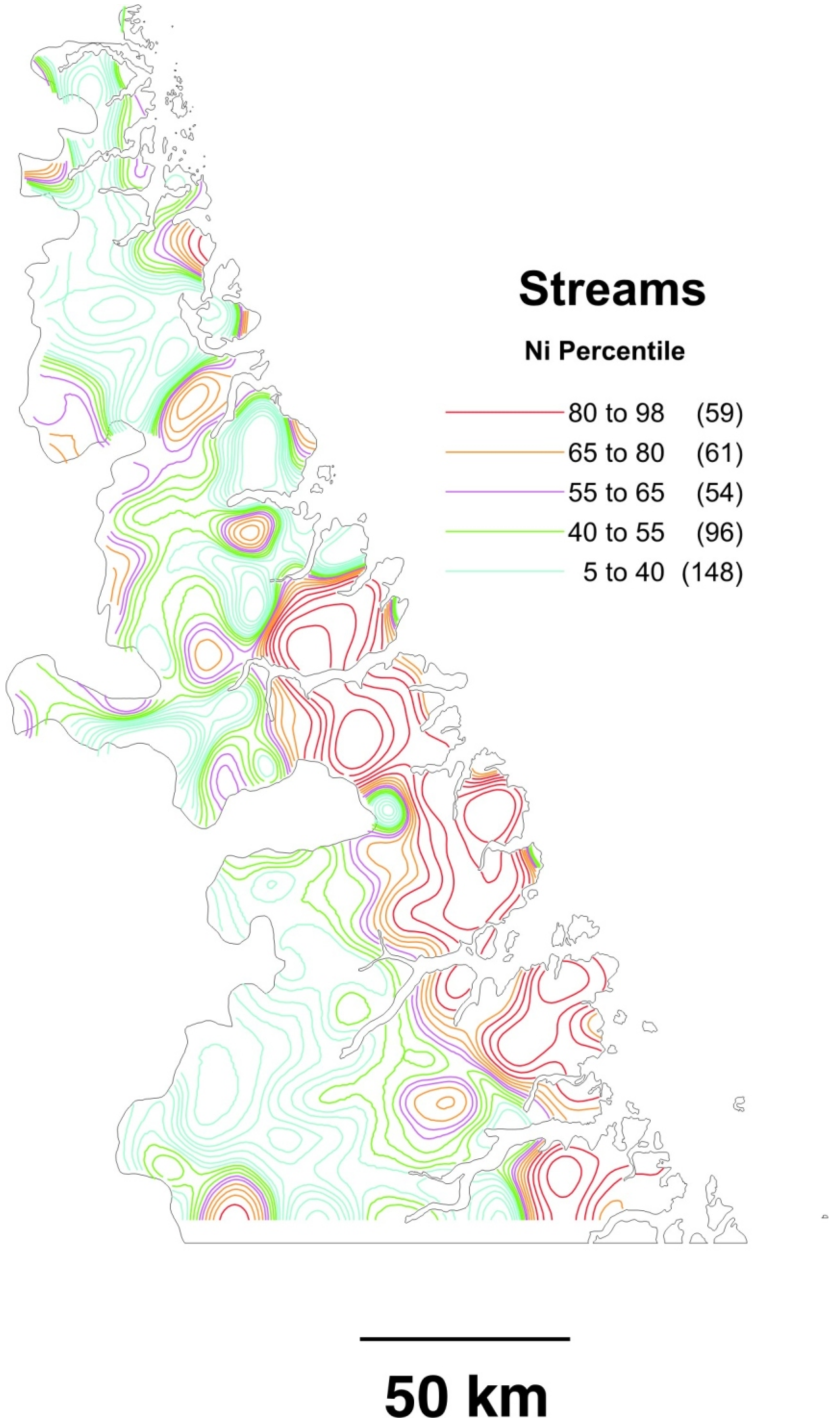

Figure 6. *Interpolated distribution of nickel as line contours in regional stream-sediment geochemical data, northern Labrador.*

approximate lake areas in hectares. The Quebec–Labrador border and the sea coast are contained in a single line layer OUTLINE, which has a single attribute LINECODE having the values BORDER and COAST.

As a frame of reference the National Topographic System (NTS) grid is included as both a polygon layer (GRIDPOLY) and a line layer (GRIDLINE). GRIDPOLY contains three attribute fields MAP_250K, which gives the 1:250 000-scale map reference, MAP_50K, which gives the 1:50 000-scale sheet within the 1:250 000-scale quadrangle, and MAPNAME, which gives the 1:50 000-map sheet name.

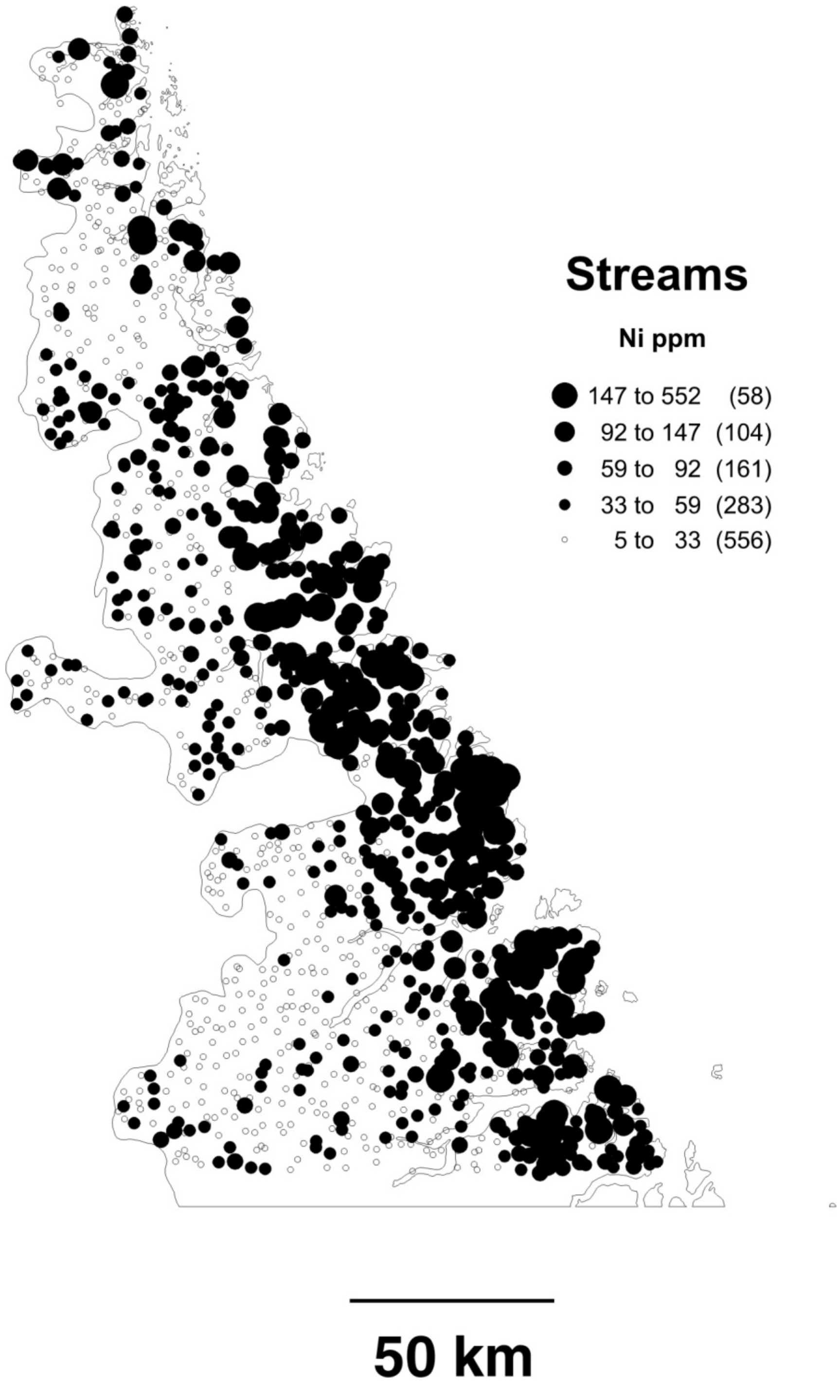

Figure 7. *Distribution of nickel as proportionally sized symbols in regional stream-sediment geochemical data, northern Labrador.*

DATA ORGANIZATION

For the atlas, the information is formatted for use with the popular commercial desktop GIS Arcview 3.0 and Mapinfo 4.0 (and higher versions of both). The data are organized to make display and manipulation as straightforward as possible, and are documented through a set of help files that can be opened with the viewer. All layers are presented in the North American Datum 1927 (NAD27), using a Universal Transverse Mercator (UTM) projection based on zone 20.

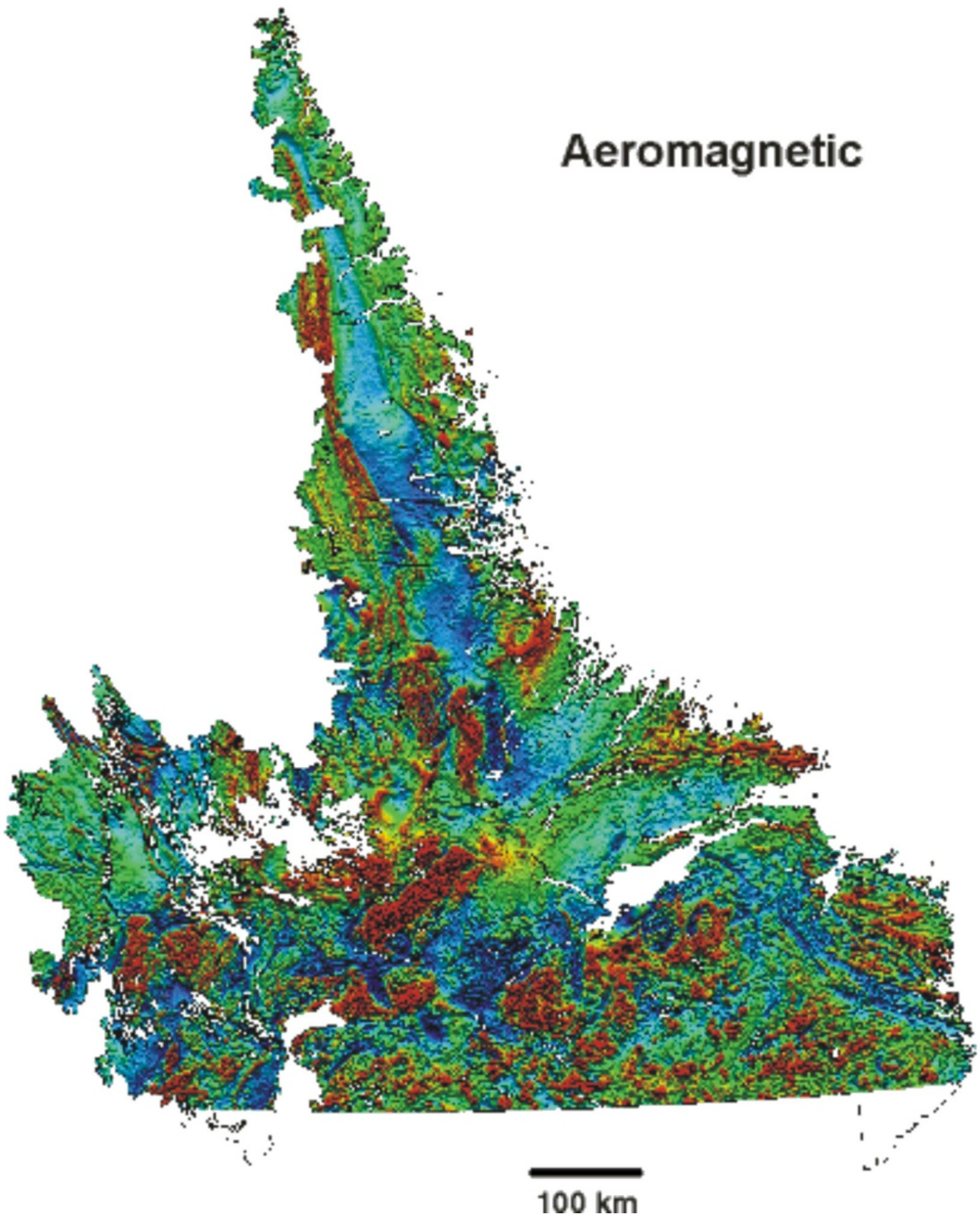

Figure 8. *Shaded-relief, colour image of the interpolated regional aeromagnetic field for Labrador.*

CONCLUSION

This initial version (1.0) of the atlas incorporates currently available information for each of the main themes. Updates are anticipated to the geochemical layers with the addition of analytical data for a further 12 elements, and for the mineral deposits information with the addition of more detailed information including references for each occurrence. For parts of Labrador of particular interest, further compilations of more detailed information in a similar format are planned. The inclusion of a customized data viewer with subsequent atlases is also envisaged.

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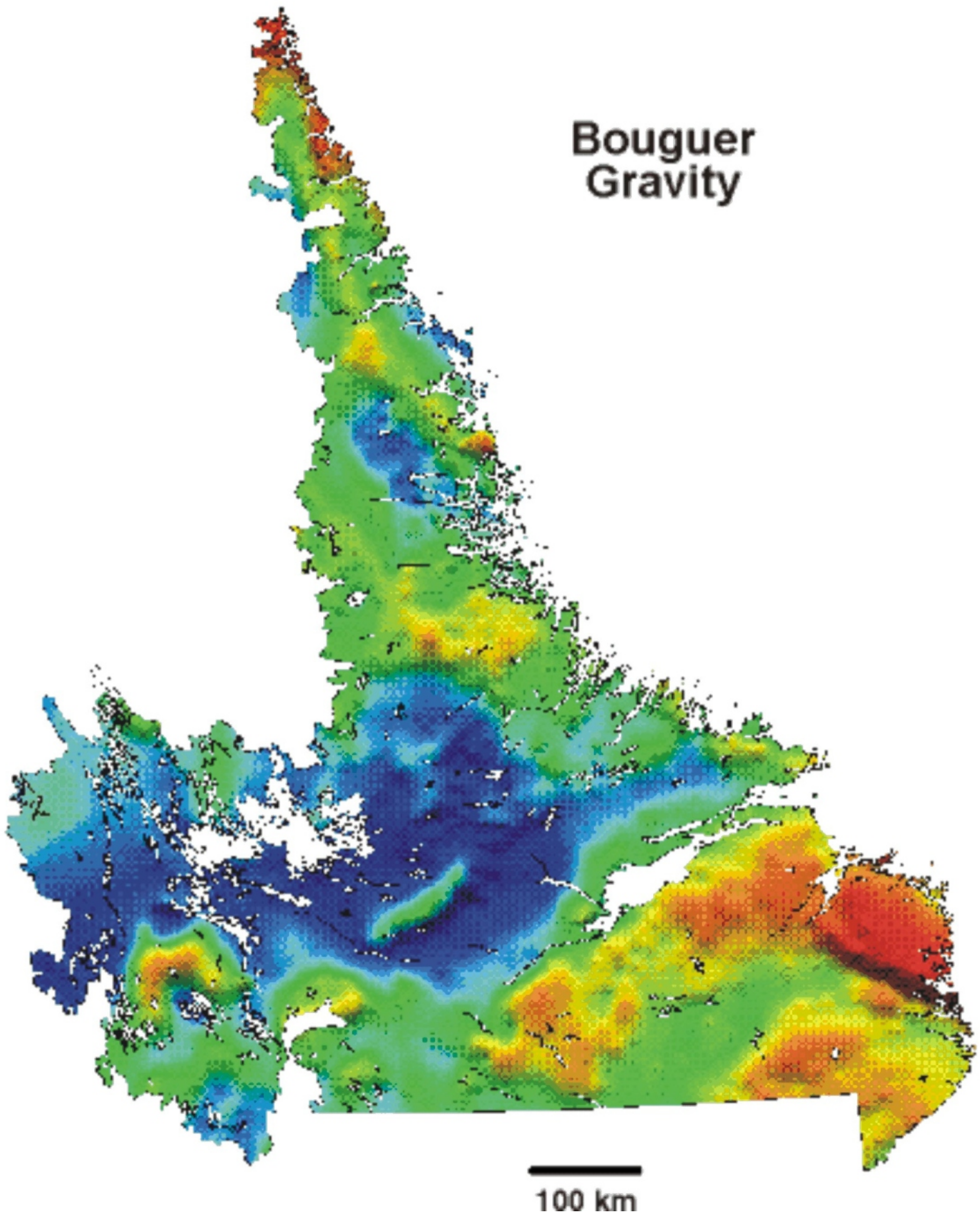

Figure 9. *Shaded-relief, colour image of the interpolated regional Bouguer gravity field for Labrador.*

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