Newfoundland Labrador

Natural Resources

Mines

ACCESSING AND USING PUBLIC GEOCHEMICAL DATA IN NEWFOUNDLAND AND LABRADOR

S.D. Amor

Open File NFLD/3207

St. John's, Newfoundland
April, 2013

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ABSTRACT

The Geoscience Atlas of Newfoundland and Labrador incorporates a number of geochemical databases comprising analyses of lake sediment and water, till and rock. In conjunction with other Atlas layers and themes, which include bedrock and surficial geology, geophysics, mineral occurrences, and current and historic claims dispositions, the data can be used to identify regional geochemical patterns as well as targets for exploration. Regional data for lake sediment and water, and till, may be viewed in map form, and all data can be downloaded for subsequent import into Geographic Information Systems or other data-processing packages.

INTRODUCTION

The Geoscience Atlas of Newfoundland and Labrador (Davenport *et al*., 2002) is an online, interactive compendium of geographical, geological, mineral-deposit, mineral-rights, land-use, geophysical and geochemical data. The data are freely available to the public and can be accessed at any time.

This guide will concentrate on accessing geochemical data only, with emphasis on data from regional lake-sediment and water surveys. Most of the instructions applicable to these data are also applicable to the examination and downloading of till and rock data, and data from detailed lake-sediment and water surveys.

ACCESSING GEOCHEMICAL DATA

The computer that is used for this purpose should be equipped with Microsoft Internet Explorer® as some of the layers in the Geoscience Atlas may have limited functionality with other browsers.

All data-retrieval exercises begin with opening the Geoscience Online page at *http://gis.geosurv.gov.nl.ca/* (Figure 1a). At this point a message may be received, advising that the pop-up blocker of the Internet browser should be turned off.

The Geoscience Atlas is opened either by clicking on the map, or the link entitled "Interactive Maps of Geology, Geophysics, Geochemistry, Mineral Occurrences, Claims, Drill Core Reports, Maps and more". It can also be opened directly *via* the link *http://gis.geosurv.gov.nl.ca/resourceatlas/viewer.htm*. The first screen to appear when the Atlas is opened is shown in Figure 1b.

A detailed guide to the Atlas tools and layers of information is available through the Map Viewer HELP (lower right side under the heading "Links"; *see* Figure 1b).

VIEWING LAKE-SEDIMENT AND WATER GEOCHEMICAL DATA

Since the lake-sediment and water data are mainly used in support of prospecting activities (although this is not their only potential application), it may be helpful to display other layers, such as Geology and Mineral Occurrences, as well, so that the viewing and analysis of the geochemical data in an area of interest can be related to all the available and relevant information.

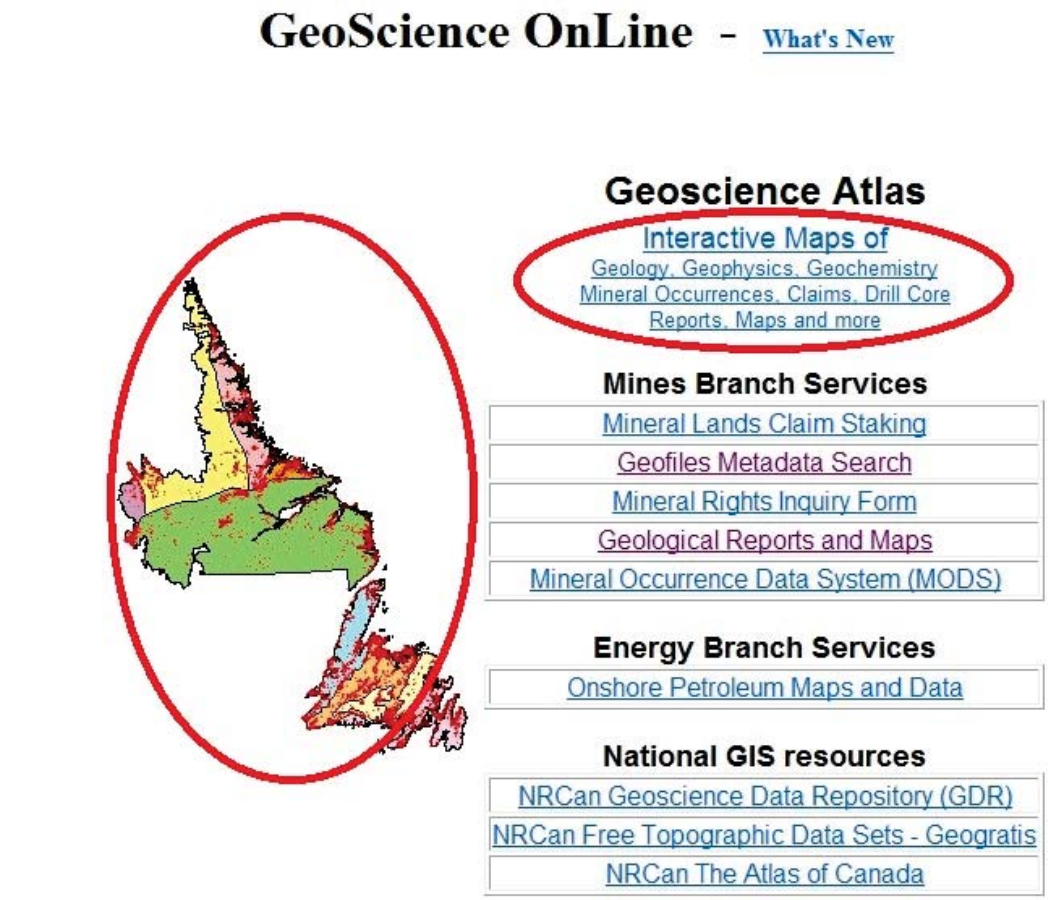

Figure 1a. *Introductory page to the Geoscience Atlas. Clicking on either of the circled links will open the Geoscience Atlas page in a new window.*

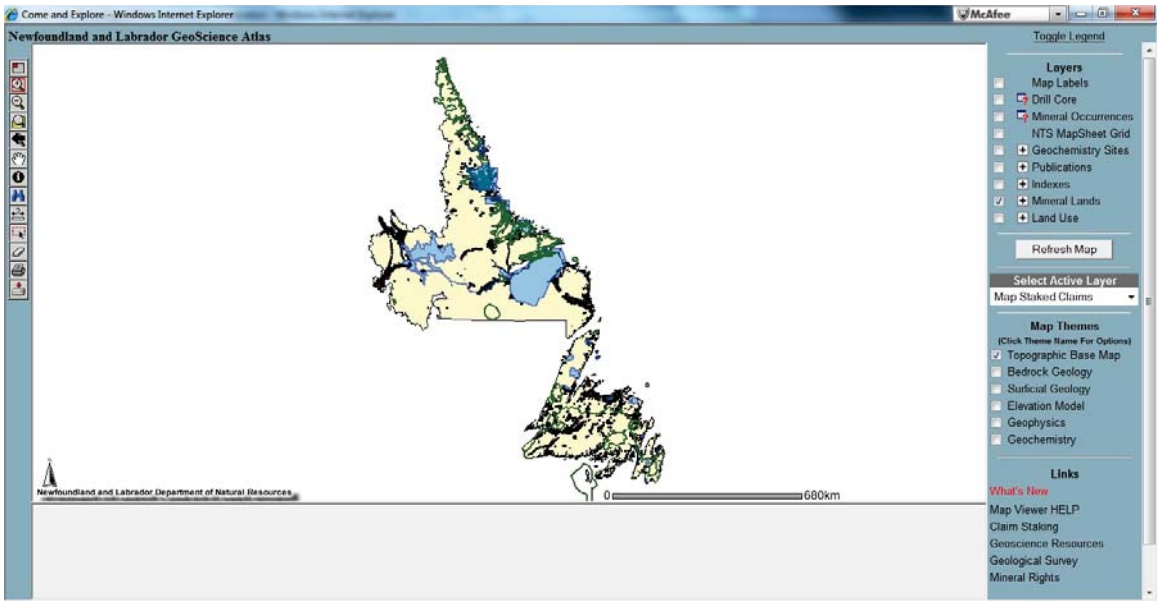

Figure 1b. *Appearance of the Geoscience Atlas when first opened.*

Two types of geochemical maps can be displayed in the Geoscience Atlas:

- Graduated geochemical symbol maps
- Colour-contour maps

When the Geoscience Atlas page is opened, the word "Geochemistry" appears under both the "Layers" (as "Geochemistry Sites") and "Themes" headings (Figure 2). Clicking on the plus (+) sign of the Geochemistry Sites Group will cause the menu to expand so that all of the geochemistry sites sublayers are shown (Figure 3). A Help file for each of the seven options is opened by clicking on the appropriate icon.

Figure 2. *Layers (above) and themes (below) of the Geoscience Atlas.*

The Lake Sediment layer consists of analyses for 48 elements, from all of Newfoundland and Labrador, collected at an average density of one sample per 7 km^2 in Newfoundland and one sample per 16 km^2 in Labrador. These data are the result of two programs: the National Geochemical Reconnaissance (NGR) program, carried out under the direction of the Geological Survey of Canada, over Labrador; and a similar program carried out over the island of Newfoundland by the provincial Geological Survey. The analyses are accompanied by UTM coordinates and certain field observations. Fluoride and uranium analyses of lake waters, for Labrador lakes only, are also included. With few other exceptions, the elements and analytical methods in the Labrador and Newfoundland datasets are the same.

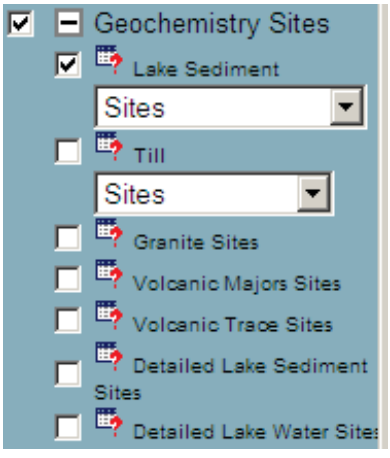

Figure 3. *Sublayers of the Geoschemistry Sites layer.*

Clicking on the icon opens a page of detailed information about the survey design, elements analyzed, and methods of sample preparation, analysis and map creation (Figure 4). In particular, there is an explanation of the numerical suffixes (*e.g.*, As1 and Cu3) that accompany each element

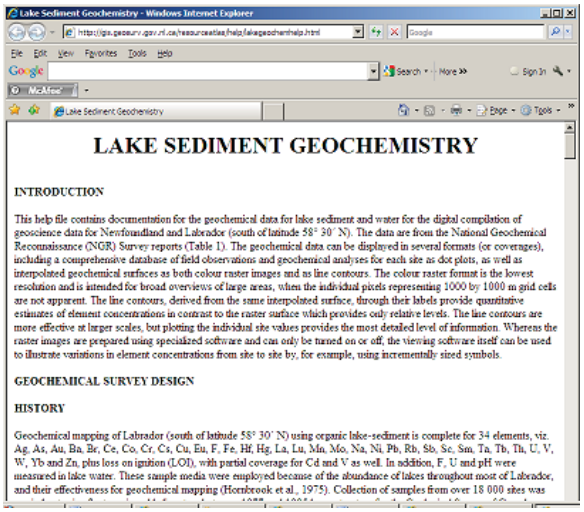

Figure 4. *Detailed lake-sediment geochemistry information.*

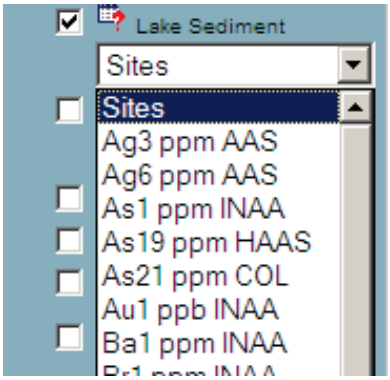

Figure 5. *Pull-down menu of detailed lake-sediment geochemistry information.*

symbol; these refer to the analytical method, in this case Instrumental Neutron-Activation Analysis (INAA) and Flame Atomic-Absorption Spectrometry (AAS) respectively, and will be described in detail later.

GRADUATED SYMBOL MAPS

The Lake Sediment pull-down menu (Figure 5) enables the display of geochemical graduated symbol maps (dot plots) for 48 elements in lake sediments and lake waters. After selecting an element for plotting, it is necessary to click the "Refresh" button to generate the map.

For most elements, seven different concentration ranges are represented by symbols of increasing sizes, although for a few there are only six (As21, Au1, Eu1, Se1). The value ranges represented by the symbol sizes can be read by clicking on the "Toggle Legend" link (*see* Figure 2).

Some of the geochemical maps in the Atlas (generally, those in which most element values are very low, with a small proportion of much higher values) are very effective in highlighting zones of enrichment, even at a very small scale. An example is molybdenum analyzed by INAA (Mo1; Figure 6). Others, such as sodium, analyzed by INAA (Na1; Figure 7), have more evenly ranged of values, with the result that areas of enrichment are not distinguishable.

GRIDDED COLOUR IMAGES AND LINE CONTOURS

Gridded colour images of most of the elements analyzed can be created by checking the box for the "Geochemistry" map theme (Figure 8). On doing so, a default contour image map of uranium, analyzed by Delayed Neutron Counting (U8) is generated (Figure 9); in order to identify the plotted element, or to select another, it is necessary to click on the word "Geochemistry" as shown

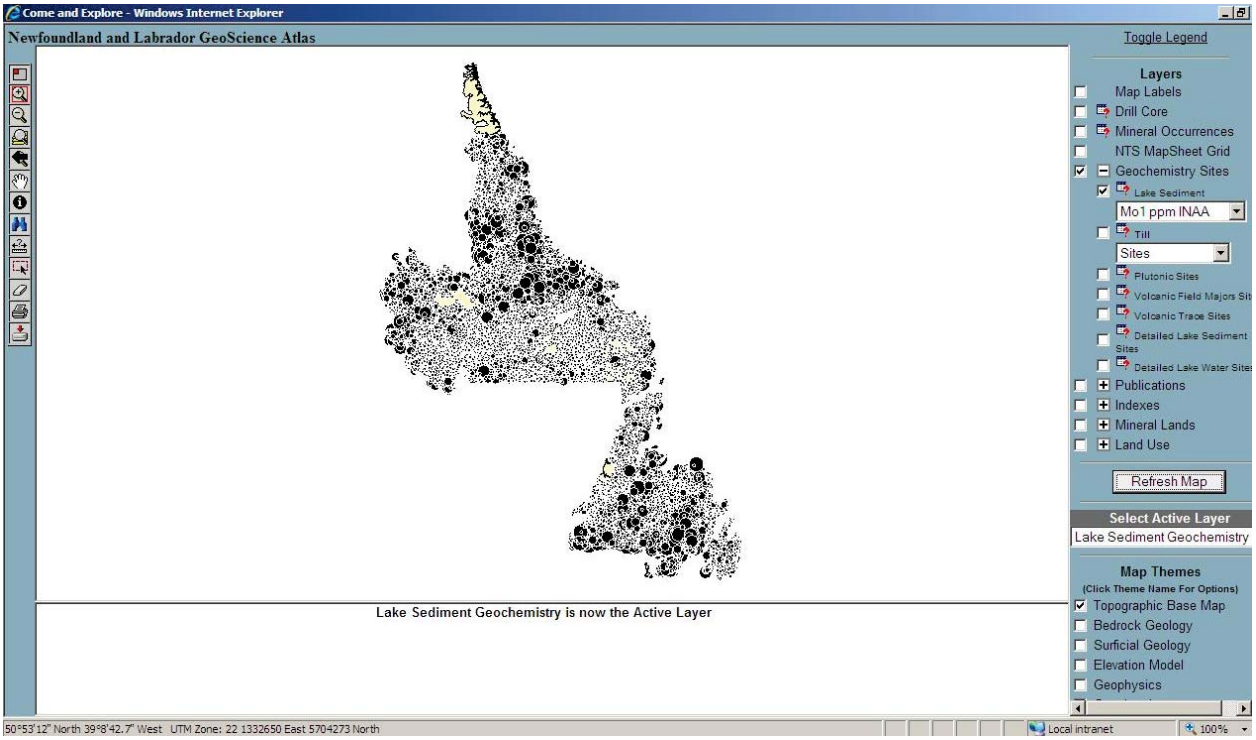

Figure 6. *Geoscience Atlas page showing molybdenum (Mo1) in lake sediments. The relatively large proporation of low values throws the areas of enrichment into sharp relief.*

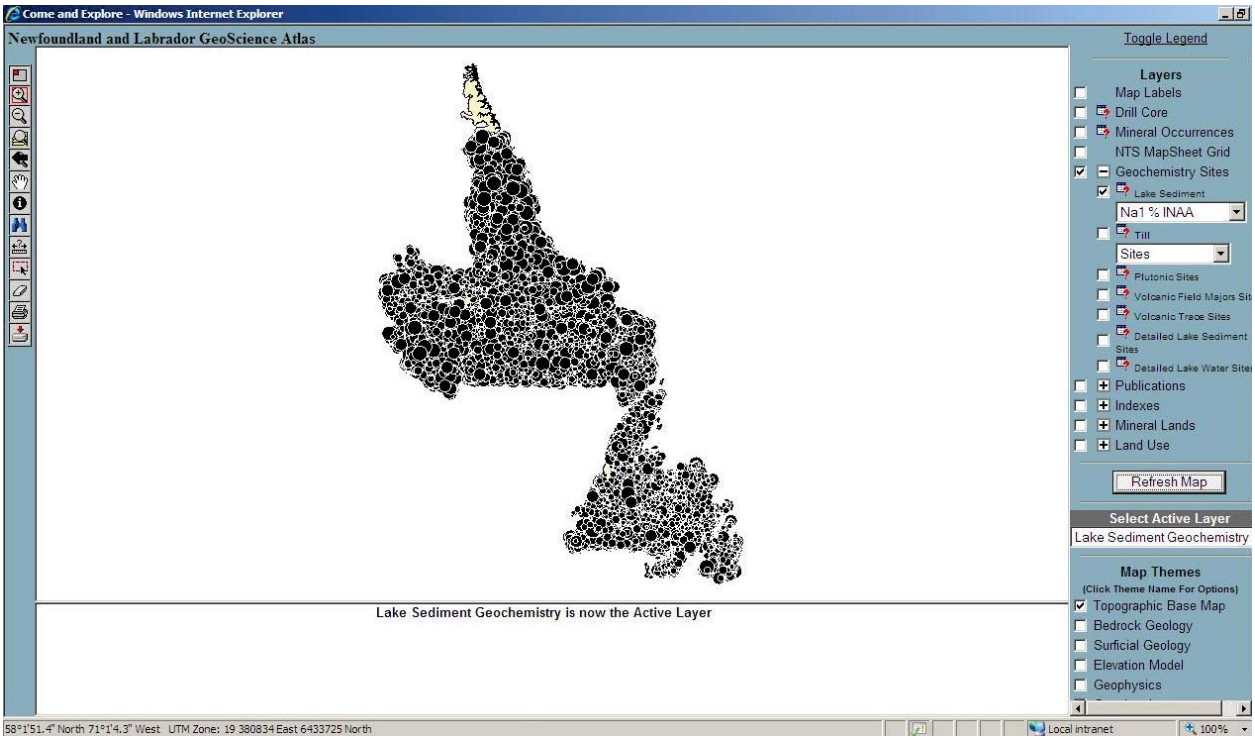

Figure 7. *Geoscience Atlas page showing sodium (Na1) in lake sediments. Values are evenly distributed over the element's range.*

Figure 8. *Pull-down menu of detailed lake-sediment geochemistry information.*

in Figure 8. This opens the option box shown in Figure 10, from which contour maps of other elements can be created.

The areas where uranium values in lake sediments are highest are contoured with the "warm" colours red and yellow; whereas those areas where values are lower are contoured with the "cold" colours green and blue. By selecting the "Contours" option as shown in Figure 10, it is also possible to display conventional line contours (not shown here). Neither the colour images nor the line contours are available to download.

Although it is possible to examine these maps at any scale, contour maps are best viewed at small scale *(i.e.*, zoomed out), to identify zones of regional enrichment. After examination of regional patterns and zooming in to such a zone, it is preferable to view the results for individual samples by another method:

1. As a symbol plot (*see* previous section),

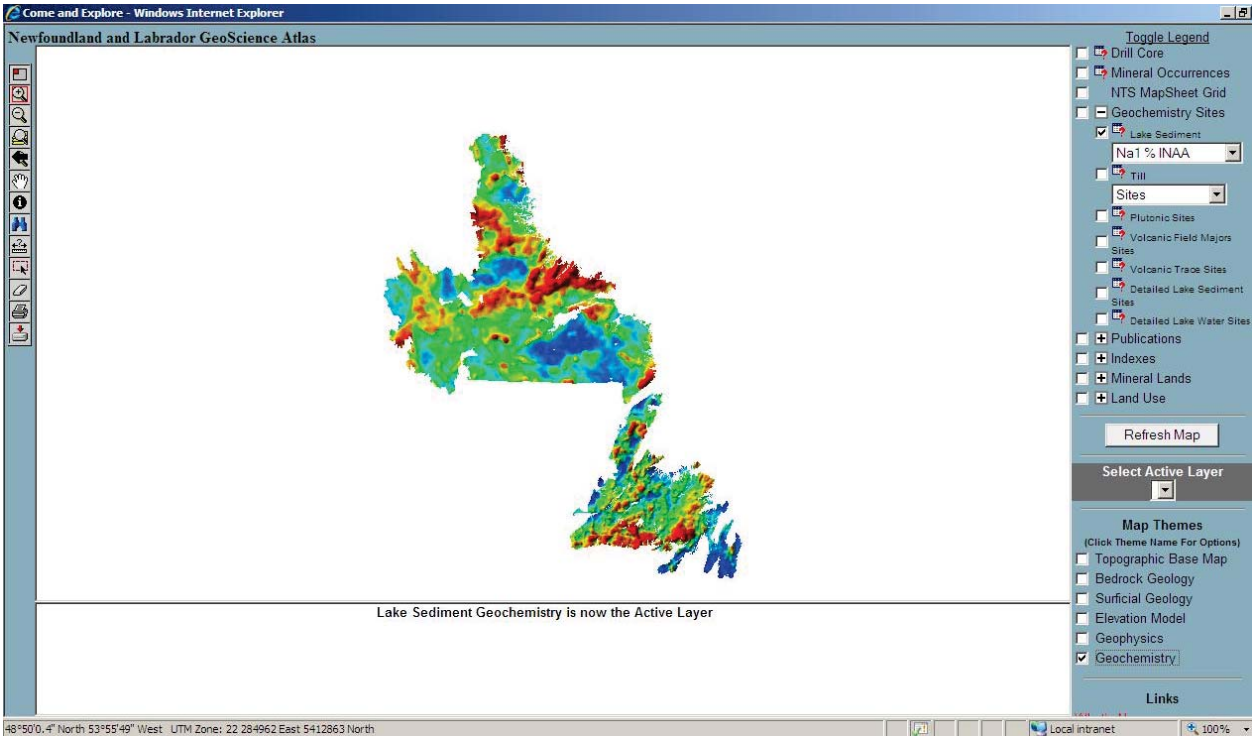

Figure 9. *Colour contours of U8 (uranium analyzed by delayed-neutron counting) over all of Newfoundland and Labrador.*

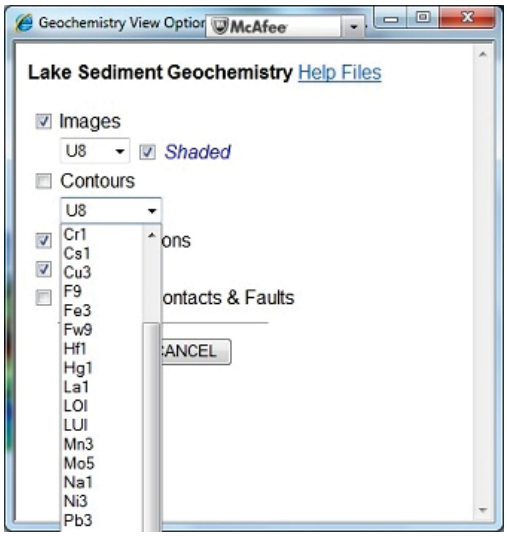

Figure 10. *View options window for interpolated colour images.*

2. By examining individual analyses, (*see* next section), or

3. By downloading the data and subjecting it to customized plotting and data-analysis procedures (*see* below).

It is possible to overlay a symbol plot on a colour-contour map, and thereby display two elements at the same time. Alternately, geochemical symbols may be superimposed on bedrock or surficial geology by selecting the appropriate map theme (*see* Figure 2). However, the smaller the scale at which the data are viewed, the more of the contours and other map information will be obscured by the symbols.

VIEWING TILL GEOCHEMICAL DATA

Till data are also stored in the Geoscience Atlas and can be accessed and downloaded from it, in the same way as lake-sediment and water data (*see* Figure 3). The till-sampling coverage is not as extensive as that of the lakes, particularly in Labrador where coverage is restricted to an area west of Port Hope Simpson, the Central Mineral Belt, and the Schefferville and Strange Lake areas. Till sampling is ongoing in Newfoundland, with new data added to the Atlas on a regular basis.

The suite of elements for which most till samples have been analyzed is more extensive than for the lake sediments, with graduated symbol plots available for 70 different element/method combinations. The data can be downloaded as zipped GIS-compatible shape files, but no image maps or contour lines are available. The Help window, accessible by clicking on the icon, includes a listing of the original reports for the till surveys from which the data were compiled.

Symbol plots for the till analyses are created in the same way as for lake sediments. Whereas the symbols for the latter are black, those of the former are dark blue. It is possible to display symbols for both tills and lake sediments or waters on the same plot. These symbols can be superimposed on a contoured geochemical map, so that if desired, three geochemical parameters can be displayed at the same time, or on a geological map, as described above.

ACCESSING ROCK GEOCHEMICAL DATA

Data for selected suites of rocks are available for visual examination, and download (in the form of zipped GIS-compatible shape files), from the Geoscience Atlas. These are continually being added to. These datasets comprise volcanic rock major-element analyses and volcanic rock trace-element analyses (selected sites from both Newfoundland and Labrador), and major- and trace-element analyses of plutonic rocks (currently from Newfoundland only).

No geochemical symbol or image maps are available, but the data may be downloaded in a GIS-compatible format for customized processing by the same method as detailed lake-sediment data (*see* below). As with the till data, the Help window, accessible by clicking on the icon, includes listings of the original reports from which the data were compiled.

DISPLAYING THE ATTRIBUTE DATA OF INDIVIDUAL SAMPLES

If "Lake Sediment Geochemistry" (Figure 3) is set as the active layer, and the Information icon is clicked on the left hand side of the screen, clicking subsequently on an individual sample point will display all of the field and analytical data for that sample. These will be displayed at the bottom of the screen (Figure 11).

If, instead of the information icon, the Select by Rectangle icon is selected, it is possible to select one or more samples by clicking and dragging a selection rectangle with the mouse. Results are presented at the bottom of the screen, as in Figure 11.

DOWNLOADING GEOCHEMICAL DATA

In some cases it may be preferable to download geochemical data (lake-sediment, till or rock data) from the Geoscience Atlas for processing and display on the user's own computer. Clicking on the Download Data icon will cause data for all of the samples displayed on the screen to be packaged in a zipped file, and the message shown in Figure 12 to be displayed. Clicking on the "Download" link will enable the zipped file to be saved on the user's computer. Unless the map

RECORD	SAMPLE_ID	NTS	AG3_PPM	ZN3_PPM	LOI_PCT	INAAWT_G	PHW	LAKAREA_HA	LAKESIZE	SAMPDPTH_M	DEPTH_M	YEAR	VEGETATION	COLOUR	SAMPCOMPOS	CONTAMINAT	CONTAMIN	UTMZONE	UTMEAST	UTMN
1786	781192	23J	1.1	200	33.8	-9	6.5	-9	.25-1km2	-9	40	1978		Brown			0	19	636506	60433

Figure 11. *Sample information displayed after selecting the information icon and clicking on a sample point. All analytical data between AG3_PPM and ZN3_PPM have been omitted to facilitate display.*

Figure 12. *Message announcing availability of data for download.*

extents of the screen correspond exactly to the user's area of interest, the downloaded dataset will probably include data for some unwanted samples, which can be edited out once the files have been unzipped.

An ESRI shape file (with the extension .shp) and its associated files are contained within the zipped file (Figure 13), all of which are required if the data are to be opened in a Geographic Information System (GIS).

Although the downloaded data are presented in a format that is particularly suitable for direct opening in many GIS programs, it is sometimes convenient to process the attribute data (*e.g.*, geochemical data) using other applications. The data are contained within a dBase file (Lake Seds.dbf), which can be readily copied and loaded into MS-Excel or various other applications for simple or specialized processing and display.

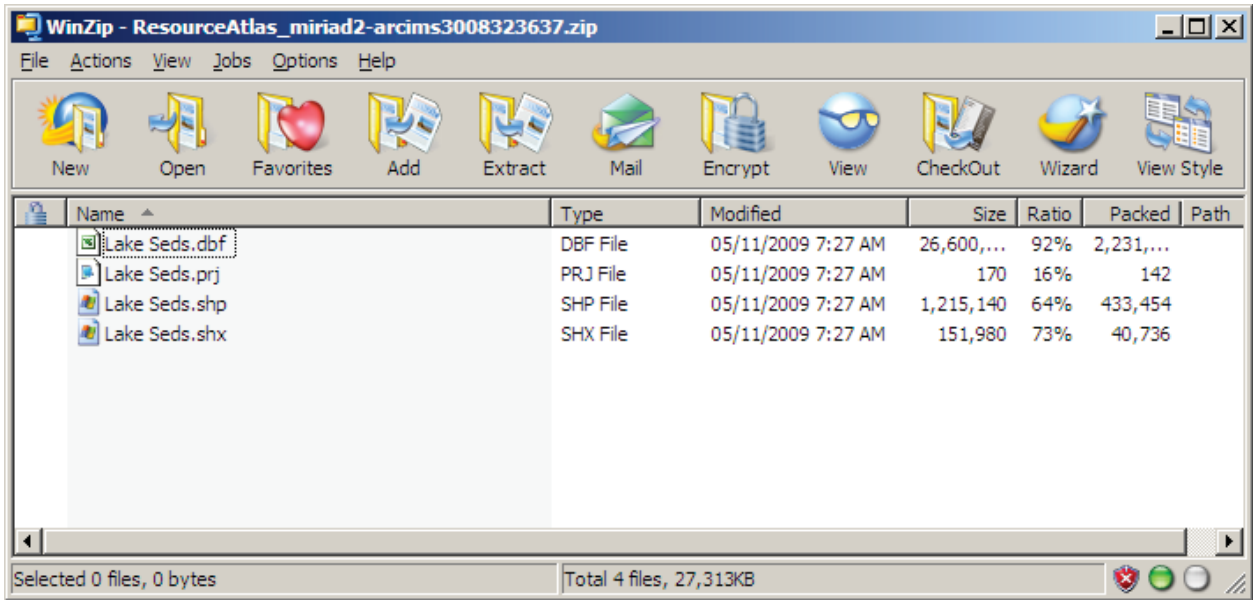

Figure 13. *Zipped files downloaded from the lake-sediment database in the Geoscience Atlas.*

DETAILED LAKE-SEDIMENT AND WATER DATA

Since 1978, a number of focussed, detailed lake-sediment sampling programs have been carried out at various localities in Labrador. In many cases, the surveys were prompted by encouraging results from the regional surveys, or favourable geology for mineralization of various types.

No graduated geochemical symbol maps, image maps or contour lines are available, but the procedure for downloading these data is as follows:

1. The box for “Detailed Lake Sediment Sites” or “Detailed Lake Water Sites” is checked, and the screen refreshed, to show the locations of the samples.
2. The screen is zoomed to the samples of interest.
3. The remainder of the procedure is the same as for regional lake data.

The Help window, accessible by clicking on the  icon, includes listings of the original reports from which the data were compiled.

ACKNOWLEDGMENTS

This report benefitted from many fruitful discussions with Patrick O’Neill of the Matty Mitchell Prospectors Resource Room, and from insightful reviews by Pauline Honarvar and Martin Batterson.

REFERENCE

Davenport, P.H., Nolan, L.W., Butler, A.J., Wagenbauer, H.A. and Honarvar, P.
2002: The geoscience atlas of Newfoundland. Newfoundland and Labrador Geological Survey, Open File NFLD/2687, Version 1.1.

APPENDIX 1

ELEMENTS AND ANALYTICAL METHODS FOR SEDIMENT, WATER, TILL AND ROCK SAMPLES

Lake-sediment, lake-water, till and rock chemical analyses are described in terms of their elemental symbol and a numeric suffix denoting their method of analysis (*i.e.*, digestion reagent, where applicable, and instrument) and in some cases, the laboratory where the analyses were performed as follows.

NO SUFFIX: GRAVIMETRIC ANALYSIS

This technique is only used for the determination of Loss on Ignition (LOI), whereby a sample is weighed before and after heating to 1000ºC. Depending on the nature of the sample, it may represent the contained water and carbon dioxide in a sample (in the case of rocks and tills) or its organic content (in the case of lake sediments). Certain elements concentrate preferentially into either the organic or inorganic fractions of lake sediments, to such an extent that false anomalies may be created; and the LOI content is a useful monitor of the relative amounts of organic and inorganic material in the sediment.

SUFFIX 1: NEUTRON ACTIVATION (INAA)

This is a "total" analytical method; that is, all of the element contained in a sample is measured without it being necessary to digest it using strong acid or another leaching reagent. Of the methods used to analyze the samples of lake sediment, lake water and till in the Geoscience Atlas, the Neutron Activation method is unique in this respect. Neutron-activation analyses denoted by this suffix have been carried out by the commercial enterprises XRAL, ActLabs and Becquerel.

Elements analyzed by INAA on some or all samples of lake sediment and till in the Geoscience Atlas include silver (Ag)*, arsenic (As)*, gold (Au), barium (Ba), bromine (Br), cadmium (Cd)*, calcium (Ca)*, cerium (Ce), cobalt (Co)*, chromium (Cr), cesium (Cs), europium (Eu), iron (Fe)*, hafnium (Hf), iridium (Ir), lanthanum (La), lutetium (Lu), molybdenum (Mo)*, sodium (Na), neodymium (Nd), nickel (Ni)*, rubidium (Rb), antimony (Sb), scandium (Sc), samarium (Sm), selenium (Se), strontium (Sr)*, tantalum (Ta), terbium (Tb), thorium (Th), uranium (U)*, tungsten (W), ytterbium (Yb), zirconium (Zr)* and zinc (Zn)*. Elements endorsed with an asterisk are also analyzed by other methods in some samples.

SUFFIX 2: ICP-OES / MULTIACID DIGESTION

Induction-Coupled Plasma-Optical Emission Spectrometry (ICP-OES) is a "wet-chemical" method; that is, the metallic constituents must first be leached from the sample into aqueous solution. In this case, the leaching reagent consists of a combination of perchloric ($HC1O_4$), hydrofluoric (HF) and hydrochloric (HCl) acids; the intended effect being that all mineral phases are broken down, and their metallic constituents go into solution. In practice this is not always achievable, with minerals such as zircon, chromite and barite resisting even this powerful acid combination.

This method has been used on most till samples, and lake-sediment samples collected in the detailed surveys, but not lake-sediment samples from the surveys covering all of Newfoundland and Labrador (*see* next section). Elements analyzed include aluminum (Al), arsenic (As), barium (Ba), beryllium (Be), calcium (Ca), cadmium (Cd), cerium (Ce), cobalt (Co), chromium (Cr), copper (Cu), dysprosium (Dy), iron (Fe), gallium (Ga), potassium (K), lanthanum (La), lithium (Li), magnesium (Mg), manganese (Mn), molybdenum (Mo), sodium (Na), niobium (Nb), nickel (Ni), phosphorus (P), lead (Pb), rubidium (Rb), scandium (Sc), strontium (Sr), thorium (Th), titanium (Ti), vanadium (V), yttrium (Y), zinc (Zn) and zirconium (Zr). The analyses have been carried out in the laboratory of the Geological Survey of Newfoundland and Labrador (GSNL) in St. John's.

SUFFIX 3: ATOMIC ABSORPTION / AQUA REGIA DIGESTION

Flame Atomic Absorption Spectrophotometry (FAAS) is also a "wet-chemical" method and, as such, requires some means of getting the metals contained in the sample into solution. Aqua Regia, which is a combination of 3 parts concentrated hydrochloric acid (HCl) to one part concentrated nitric acid (HNO_3) was applied to lake-sediment samples from Labrador and Newfoundland prior to the introduction of ICP-OES (*see* above), at the laboratories of the Geological Survey of Canada (GSC) and the GSNL, respectively.

This digestion reagent is commonly used on lake-sediment samples, as well as stream sediment, soil and till (*see* next section) and even pulverized rock at some commercial laboratories, but it is not capable of completely dissolving minerals like quartz and feldspar, certain silicate minerals, or the minerals that are refractory to the multiacid digestion. The term "flame" refers to the acetylene flame that converts the resulting solution to a vapour within which the contained metals are detected and measured.

The samples were analyzed by this method for silver (Ag – Labrador samples only), cadmium (Cd; selected map sheets only), cobalt (Co)*, copper (Cu), iron (Fe)*, manganese (Mn), nickel (Ni)*, lead (Pb) and zinc (Zn). Elements endorsed with an asterisk are also analyzed by other methods in some samples.

SUFFIX 4: ATOMIC ABSORPTION / AQUA REGIA DIGESTION

This method of digestion and analysis is the same as Method 3, but applies to stream sediments, soils and tills, as opposed to lake sediments, analyzed at the GSNL laboratory.

SUFFIX 5: ATOMIC ABSORPTION / AQUA REGIA + Al^{3+} DIGESTION

This method of digestion and analysis is similar to Methods 3 and 4; however, a small amount of trivalent aluminum is added to stabilize the molybdenum (Mo) and vanadium (V) compounds in the solution, so that they remain detectable by the analysis. This method was applied at the GSC's laboratory to lake-sediment samples from Labrador for both Mo and V, and at the GSNL laboratory to lake-sediment samples from Newfoundland, for Mo only.

SUFFIX 6: ATOMIC ABSORPTION / NITRIC ACID DIGESTION

Pure nitric acid is used in preference to Aqua Regia, which contains hydrochloric acid, to digest all geochemical samples for silver (Ag) analysis, because the insolubility of silver chloride may cause some of that element to precipitate out and be unavailable for detection. This method was applied by the GSNL laboratory to lake-sediment samples collected on the Island of Newfoundland, although conventional Aqua Regia digestion was used by the GSC.

SUFFIX 8: DELAYED NEUTRON COUNTING (DNC)

This method is used primarily for uranium (U) analysis. Like neutron-activation analysis, and unlike most of the "wet-chemical" techniques, the total content of uranium is measured and results are generally very similar to those of neutron activation, although DNC has an upper detection limit of about 1000 ppm. As with neutron-activation analyses, the work requires access to a nuclear reactor and the work was contracted out to Activation Laboratories (ActLabs) of Ancaster, Ontario.

SUFFIX 9: ION-SELECTIVE ELECTRODE (ISE)

This very sensitive method is used for determination of elemental fluorine in sediments, and fluoride ion in lake waters. It was, and continues to be, carried out on all sediment samples from regional and more detailed samples from both Newfoundland and Labrador at the GSNL laboratory.

SUFFIX 18: AQUA REGIA; COLD-VAPOUR ATOMIC ABSORPTION

This method is specific to mercury (Hg) and takes advantage of that element's tendency to vaporize at relatively low temperatures, removing the need for a high-temperature flame. The method was used on lake-sediment samples from Labrador, by the GSC, but has not been applied to lake-sediment samples collected in Newfoundland, or any other sample media.

SUFFIX 19: HYDRIDE ATOMIC ABSORPTION

Certain elements, notably arsenic and antimony, have non-metallic character and readily form gaseous hydrides that are amenable to atomic-absorption. This method was used by the GSC to analyze about 76% of the lake-sediment samples from Labrador and was the method of choice for both elements until neutron-activation analyses became readily available.

SUFFIX 21: COLORIMETRY

This method, one of the earliest developed for analyzing trace amounts of arsenic (and many other metals) was applied by the GSC to the remaining 24% of the lake-sediment samples from Labrador not analyzed by Hydride Atomic Absorption.

SUFFIX 25: ICP-OES / LITHIUM TETRABORATE ($LiBO_2$) FUSION

This method was applied at the GSNL laboratories to the analysis of chromium (Cr) and zirconium (Zr) on a limited number of lake-sediment samples from the detailed lake-sediment sampling programs. Many minerals that host these elements are resistant to digestion by even the strongest acids; hence the application of a fusion technique to get these elements into solution.

SUFFIX 26: NEUTRON ACTIVATION

This method denotes Neutron Activation analysis carried out in 1978 by Atomic Energy Canada (AEC) on a batch of 746 detailed lake-sediment samples. The analytical method is essentially the same as that denoted by suffix 1.

SUFFIX 27: FIRE ASSAY / ICP-MS

The fire-assay technique can be used to concentrate trace amounts of gold and other precious metals to the point where they can be measured by conventional methods more suited to more abundant elements. Combination of fire-assay pre-concentration with inductively-coupled mass spectrometry (ICP-MS) produces a highly sensitive analysis, of which 595 were performed at Activation Laboratories Ltd. for palladium (Pd) and platinum (Pt) on samples from the detailed lake-sediment dataset.

APPENDIX 2

ELEMENTS AND ANALYTICAL METHODS FOR WATER SAMPLES

NO SUFFIX

The conductivity of the waters was measured with a Corning conductivity sensor. Readings are available for about 50% of the samples in the Detailed Water Database for Labrador.

The pH, a metric of the acidity (values less than 7.0)/alkalinity (values greater than 7.0) of the water, was measured at the GSNL laboratories with the Corning combination pH electrode. All of the water samples in the regional lake-sediment/water database, and approximately 80% of the samples in the detailed water database, have pH measurements.

SUFFIX hvymtl_w: (TOTAL HEAVY METAL)

This refers to the combined content of Cu, Zn and Pb. About 8% of the detailed water samples from a 1979 program were analyzed for this parameter by a colorimetric method, which seems rather primitive from a contemporary perspective, but which has the advantage that analyses can be performed in a field laboratory.

SUFFIX w1: ICP-OES

For the relatively abundant elements Ca, Fe, K, Mg, Mn, Na, Si and SO_4 (sulphate ion), conventional inductively-coupled plasma-optical emission spectrometry, as applied to digested lake sediment and till samples (suffix 2), is used. About 50% of the water samples from the detailed lake-sediment surveys have been subjected to this analysis at the GSNL laboratories.

SUFFIX w2: ICP-OES - ULTRASONIC NEBULIZER

The less abundant elements Al, As, Ba, Be, Co, Cr, Cu, Li, Mo, Ni, P, Pb, Sr, Ti, V, Y, Zn can be analyzed by conventional ICP-OES if an ultrasonic nebulizer, which creates a fine mist of the water sample, is available to provide the necessary signal enhancement. About 50% of the water samples from the detailed lake-sediment surveys have been subjected to this analysis at the GSNL laboratories.

SUFFIX w3: INDUCTIVELY COUPLED PLASMA-EMISSION MASS SPECTROMETRY

This sensitive method is suitable for determination of As, Ba, Be, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Gd, Ho, In, La, Li, Lu, Mn, Mo, Nd, Ni, Pb, Pr, Rb, Re, Se, Sm, Sr, Tb, Th, Ti, Tl, Tm, U, V, Y, Yb and Zn, although its relatively recent introduction means that less than 5% of the water samples in the detailed lake-water database have been analyzed in this way, in many cases for a rather small subset of these elements, at various commercial laboratories. The 2012 installation of

a mass-spectrometry unit will enable these analyses to be performed at the GSNL laboratory in future.

SUFFIX w9: ION-SELECTIVE ELECTRODE

This method is used to determine fluoride ion content. All of the water samples in the regional Labrador database, and about 35% of the detailed water samples, were subjected to this method (at the laboratories of the GSC and GSNL, respectively), although it was not applied to the regional samples from Newfoundland.

SUFFIX w10: FLUORIMETRY

Analyses by this sensitive method of uranium detection were performed by Bondar Clegg Ltd. and applied to 50% of regional lake-water samples from Labrador (the other 50% being subjected to Fission Track analysis; *see* below), and 20% of the detailed lake-water samples from the detailed programs.

SUFFIX w11: FISSION TRACK ANALYSIS

This method involves the irradiation of the water sample with thermal neutrons and the electronic counting of the uranium fissions that take place. All of the regional lake-water samples from Labrador, that were not analyzed by fluorimetry (*see* above) were analyzed by this method at AEC. The method was not applied to samples from Newfoundland.

SUFFIX w12: DITHIZONE/COLORIMETRIC

About 12% of the lake waters, from an early detailed survey in Labrador, were analyzed by this long-supplanted method, which can be carried out in a very basic field laboratory. The method consists of shaking a water sample, suitably acidified or buffered, with dithizone (diphenylthiocarbazone) to form a metal dithizonate; these are typically of bright, distinctive colours, whose tone and intensity can be compared to a set of standards.