

# THE GEOSCIENCE ATLAS: TOWARD A COMPREHENSIVE GEOSCIENCE KNOWLEDGE-BASE FOR NEWFOUNDLAND AND LABRADOR

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## ABSTRACT

*The Newfoundland and Labrador Geoscience Atlas portal is a collection of data layers and tools used to explore geoscience and related mineral exploration information for the Province. Combined with topographic base maps, the geoscience layers are presented in an internet mapping application that enables the user to view, query and download information for any area of the Province.*

*The point, line and polygon layers consist of bedrock, till, lake sediment and water geochemistry, mineral occurrences, indexes to bedrock, geochemical, and airborne geophysical surveys, and mineral lands and land-use information. These can be overlain on base-map themes, such as topography, bedrock and surficial geology, geophysics, an elevation model, or gridded geochemistry. With the tools provided, any location can be queried to show which company is exploring the land, if any reports have been submitted about a land parcel, if mineral occurrences exist nearby, or if it has been mined. Other tools can be used to zoom, pan, download data or print a map. This can be accomplished from anywhere using the internet.*

*In the next few years the Geoscience Atlas will be redesigned to keep up with the changing internet mapping technology. This includes ready access to raster images, larger datasets, cached datasets, more complex queries, and support for mobile devices and tablets.*

## INTRODUCTION

The Geoscience Atlas is the public internet portal to view, query and download geoscience datasets of Newfoundland and Labrador. These datasets include complete regional coverage for bedrock and surficial geology, lake sediment geochemistry and aeromagnetic geophysics. Other geoscience datasets, updated as data are compiled, include mineral occurrences, lithogeochemistry of plutonic and volcanic rocks, drillcore, and indexes to bedrock maps, geochemical surveys and airborne surveys. Topographic data, such as lakes, rivers and wetlands, are provided as cached base-map images at various scales.

All this data can be viewed in the context of the land status, including present and historical claim boundaries, claims coming open, park and exempt mineral lands, and land-use information, such as municipal boundaries, and public water supplies. Help files are provided throughout the Atlas, describing the tools and the database layers.

The goal of the Geoscience Atlas portal is to enable clients to gain easy access to a geospatial view of the geo-

science data of the Province and to be able to download the data. The clients include the mineral exploration community, internal government clients from our own or other departments, educational institutions as well as the general public. Aside from the main use of the Atlas for mineral exploration and earth-science research, the geoscience information is also of use for land-use planning, baseline environmental evaluations, natural hazards identification as well as tourism and educational purposes. Those who lack the programs (e.g., Geographic Information Systems such as *ArcGIS* or *MapInfo*) to view, query and analyze the data on their own computer can use the Atlas to do simple analyses and output. Those who do have access to a GIS can download the data onto their own systems for further analysis and output.

Planned upgrades to the Geoscience Atlas will include migrating to the latest *ESRI ArcGIS Server* technology, which will provide more mapping tools, enhanced printing, mobile browser support as well as access to more data, including client-generated data, reports and images.

## BACKGROUND

During the early to mid-1980s geoscience data at the Newfoundland and Labrador (NL) Geological Survey was being converted from analog to digital form. With the large amounts of geoscience data becoming available, especially geochemical data for lake and stream sediments as well as lithogeochemical data, the need to compile, manage and analyze the data required in-house access to the Provincial Government's mainframe computer at the Computer Resource Centre on Higgins Line (Missan, 1983) as well as more 'user-friendly' programs made available on in-house micro-computers (Missan, 1984).

By the mid-1980s, as more inexpensive portable computers were being widely used, digital geoscience data was being made available to our clients, usually as tabulated ASCII files, on five and a quarter or three and a half inch diskettes.

In the mid-1990s, free programs, such as *MapInfo's Proviewer* and *ESRI's ArcView1*, were available to view georeferenced data. Based on these programs, the NL Geological Survey packaged various digital geoscience datasets and made them available on CD-ROMs (Davenport *et al.*, 1996a, b, 1997, 1999a, b). These CDs included geoscience data as well as free regional topographic data (*i.e.*, 1:1 000 000-scale International Map of the World Series) to provide a spatial framework for the geoscience data.

With the advent of the internet, many of the digital geoscience datasets, along with provincial topographic layers (*e.g.*, lakes, rivers and wetlands), were organized and made available in 1996, using the online web-mapping software, *MapServer*, developed at the University of Minnesota. The datasets were kept to a limited size for ease of download by dial-up internet services. As more high-speed internet became available across the Province and the functionality of web-mapping software improved, the Newfoundland and Labrador Geoscience Atlas was redesigned in 1999 using *ESRI's ArcIMS*. As fewer clients made use of the dial-up internet services, the *MapServer* access was discontinued in 2003.

## GEOSCIENCE ONLINE AND THE GEOSCIENCE ATLAS

The GeoScience OnLine web page (<http://gis.geoserv.gov.nl.ca/>) provides direct access to the Geoscience Atlas as well as access to a number of local and national services (Figure 1). The local Mines Branch Services include links to the Mineral Lands Claim Staking system (MIRIAD), Mineral Rights Inquiries, MODS Inquiries and

Geofiles (reports) searches. The National GIS Resources consist of links to the NRCan Geoscience Data Repository, NRCan Free Topographic Datasets (Geogratis), and the Canadian Geoscience Knowledge Network.

Access to the Geoscience Atlas is either through the *Interactive Maps* link or by clicking on the image of Newfoundland and Labrador (Figure 1). This opens the Atlas to a regional view of Newfoundland and Labrador displaying the default set of layers, which include Map Staked Claims and various features of the Mineral Tenure layer, including Exempt Mineral Lands, Labrador Inuit Lands (LIL), Labrador Inuit Settlement Areas (LISA), Parks and Wilderness Reserves.

## ORGANIZATION OF THE GEOSCIENCE ATLAS

The Geoscience Atlas is organized with tools on the left side and geoscience, land use and topographic layer information on the right side (Figure 2). The layer information consists of vector point, line and polygon layers, on the upper right side of the Atlas, and base-map topographic data (as cached images) plus regional raster images and ancillary layers on the lower right, in the *Map Themes* section. The *Links* section provides additional links to help files as well as related web sites.

In the *Layers* section (upper right), datasets are grouped under the headings Geochemistry Sites, Publications, Indexes, Mineral Lands and Land Use. Individual layers, such as Till Geochemistry, can be viewed by first expanding the Geochemistry Sites group, selecting the Till Geochemistry layer and then refreshing the map window. Layers can be turned on and off individually, as well as at the group level.

The *Map Themes* section (lower right; *see* Figure 2) provides access to individual layers through options pop-up boxes, which can be accessed by clicking on the theme name. The *Map Themes* consist of Topographic Base Map, Bedrock Geology, Surficial Geology, Elevation Model, Geophysics and Geochemistry.

As an example, the Geochemistry options box provides access to images of interpolated geochemical element values as well as their respective contour lines. A drop-down list provides the choice of 30 to 40 elements, from silver (Ag3) to zinc (Zn3). The images can be shaded by turning on that option. Only elements that were of good quality were interpolated. The interpolation procedure is described in the *Geochemical Surface Interpolation* section of the *Lake Sediment Geochemistry* help file.



**Figure 1.** Access to the Geoscience Atlas is through the GeoScience OnLine home page. Links to other Mines Branch services as well as National GIS Resources are also available through this website.

Help files for most of the layers are provided as icons beside each layer. These individual help files describe such layer information as method of data collection and analysis, a description of each of the fields in the attribute tables, references, as well as contact information. An overall help file, called *Map Viewer HELP*, is available in the *Links* section (lower right). This file provides descriptions to the tools available in the Atlas as well as all the layers available.

Further links are available on the lower right side of the Atlas. These are links to a list of new items recently added to the Atlas (*i.e.*, *What's New* file), the previously mentioned *Map Viewer HELP* file, and links back to the *GeoScience OnLine* home page, the *Geological Survey* website and *Mineral Lands* information (*e.g.*, Mineral Act and Regulations and other exploration and mining reports and guidelines).

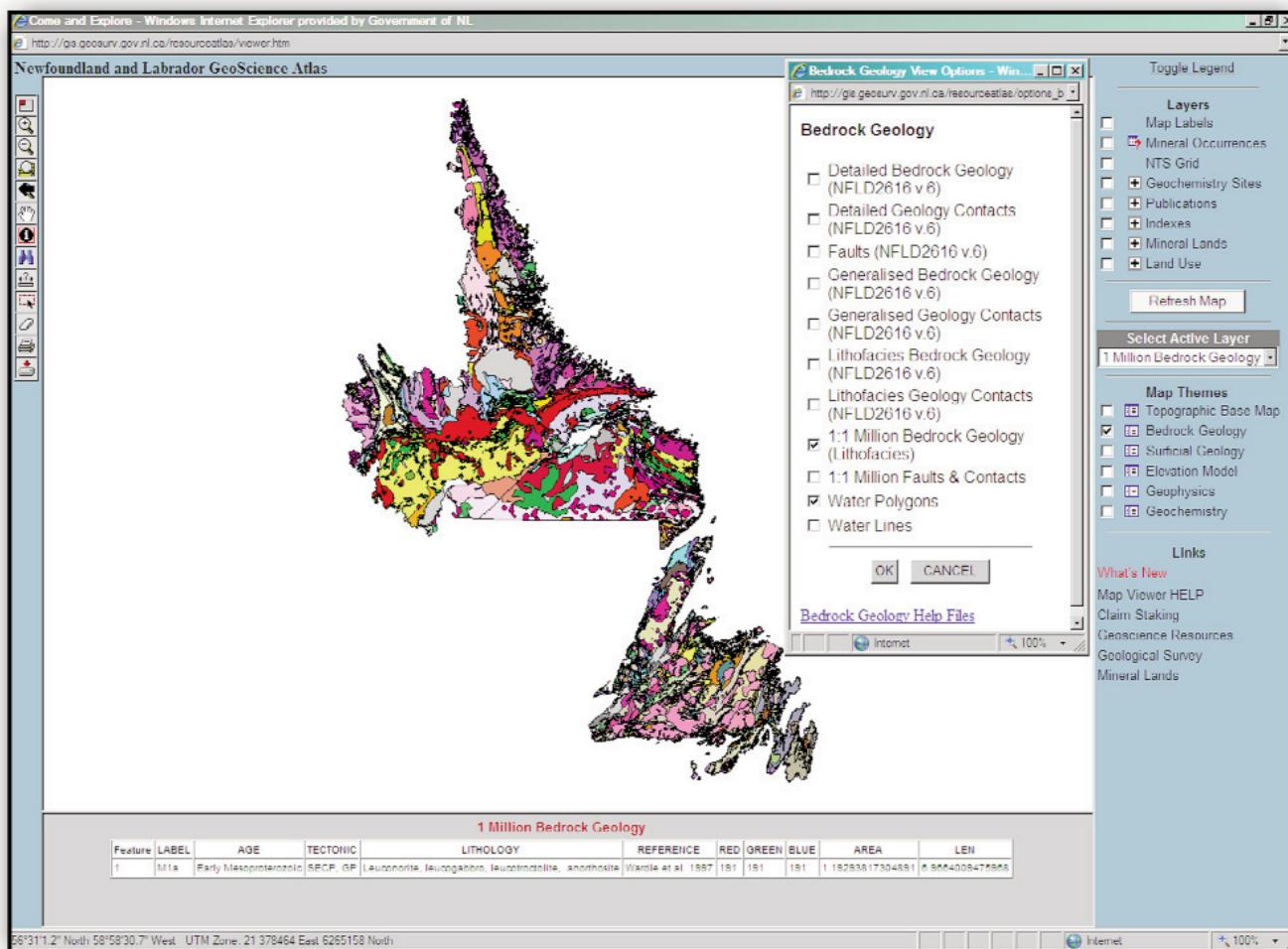
The tools on the left side of the Atlas consist of the standard tools used to move around a map window (*e.g.*, 'Zoom In', 'Pan', 'Back to last extent'). Query tools consist of the

'Identify', 'Query', and 'Select by Rectangle' tools. The results of these tools will produce data tables, associated with the selected features, in the window below the map viewer. Using these tools, any location can be queried to show which company is exploring the land, if any reports have been written about a land parcel, if mineral occurrences exist nearby or if the location has been mined.

## DOWNLOADING DATA

One of the most useful tools in the Atlas is the 'Download Data' tool, on the lower left side. This tool enables the user to download vector information. Table 1 provides a list of all layers available on the Atlas; those layers that can be downloaded are in *italics*.

Downloaded data is provided in ESRI shape file format. This is a common vector format for GIS data and can be viewed using not only ESRI's *ArcGIS* program but also other GIS (*e.g.*, *MapInfo*) as well as free geospatial viewing pro-



**Figure 2.** The Geoscience Atlas is organized with tools on the left side and layers of geoscience, land use and topographic information on the right side. Pop-up windows, from the Map Themes section, provide more options.

grams (e.g., *ArcGIS Explorer*, *Global Mapper*). An additional benefit of the shape file format is that the attribute data (*i.e.*, the tabulated data that is associated with each point, line or polygon feature) is contained in the file with a dBase (.dbf) extension. This file can be viewed using a spreadsheet program, such as *Microsoft Excel*.

The coordinate system for the downloaded data is latitude–longitude based on the 1927 North American Datum (NAD27). The geographic latitude–longitude projection is used, as opposed to Mercator projections, due to the large geographic extent of the data, crossing four UTM zones: zone 19 in western Labrador to zone 22 in eastern Newfoundland. The NAD27 datum is used to conform with the present digital topographic base maps as well as conforming to the datum used in the claim staking program ‘MIRIAD’ ([http://www.nr.gov.nl.ca/nr/mines/exploration/claimstaking/maintenance/claims\\_brochure.pdf](http://www.nr.gov.nl.ca/nr/mines/exploration/claimstaking/maintenance/claims_brochure.pdf)).

One of the disadvantages of the shape file format is that it does not contain the symbology as viewed on the Atlas (*i.e.*, colours, symbols or polygon fills). This information will have to be added manually after downloading the data. Alternatively, *ArcGIS* users can contact the database ‘owner’ (listed in the help file for that layer) and they can provide a ‘layer’ file containing the symbology. With respect to the colours for the bedrock and surficial geology polygons, these are contained in the attribute table columns as red/green/blue intensity values. Depending on the GIS program being used, the RGB values can be translated into the appropriate colour fills.

## PROGRESS AND FUTURE DIRECTIONS

Over the years, the Atlas has grown as new geoscience data has been added and other information have been deemed of interest (*e.g.*, land-use layers, digital elevation

**Table 1.** Layers available to view on the Geoscience Atlas, listed by category; note that a layer may be listed more than once if it straddles more than one category (e.g., Plutonic Geochemistry Sites are listed under Geochemistry as well as Bedrock Geology); layers that can be downloaded are in *italics*; a complete description of each layer is available in the *Map Viewer Help* file on the Atlas

**Earth Science Data:**

Bedrock Geology

*Regional 1:1 Million Geology*  
*Detailed Geology*  
*Plutonic and Volcanic Geochemistry*  
*Mineral Occurrences*  
*Index of Bedrock Maps*

Surficial Geology

*Regional Geology*  
*Detailed Geology*  
*Till Geochemistry*  
*Landforms*  
*Striations*  
*Aggregate Samples, Eskers, and Potential*

Geochemistry

*Regional Lake Sediment*  
*Detailed Lake Sediment*  
*Detailed Lake Waters*  
*Till*  
*Plutonic Rocks*  
*Volcanic Rocks*  
*Index of Geochemical Surveys*

Geophysics

*Index of Airborne Surveys*  
*Aeromag*

**Topographic Data:**

Map Labels  
*NTS Map SheetGrid*  
 UTM Grid Lines  
 National Road Network  
 Topographic Base Map  
 Elevation Model

**Mineral Lands Data:**

*Map Staked Claims*  
*Mineral Rights Cancelled*  
*Notices Gazetted*  
*Historical Claims*  
*Mineral Tenure*  
*Quarries*  
*Drill Core*

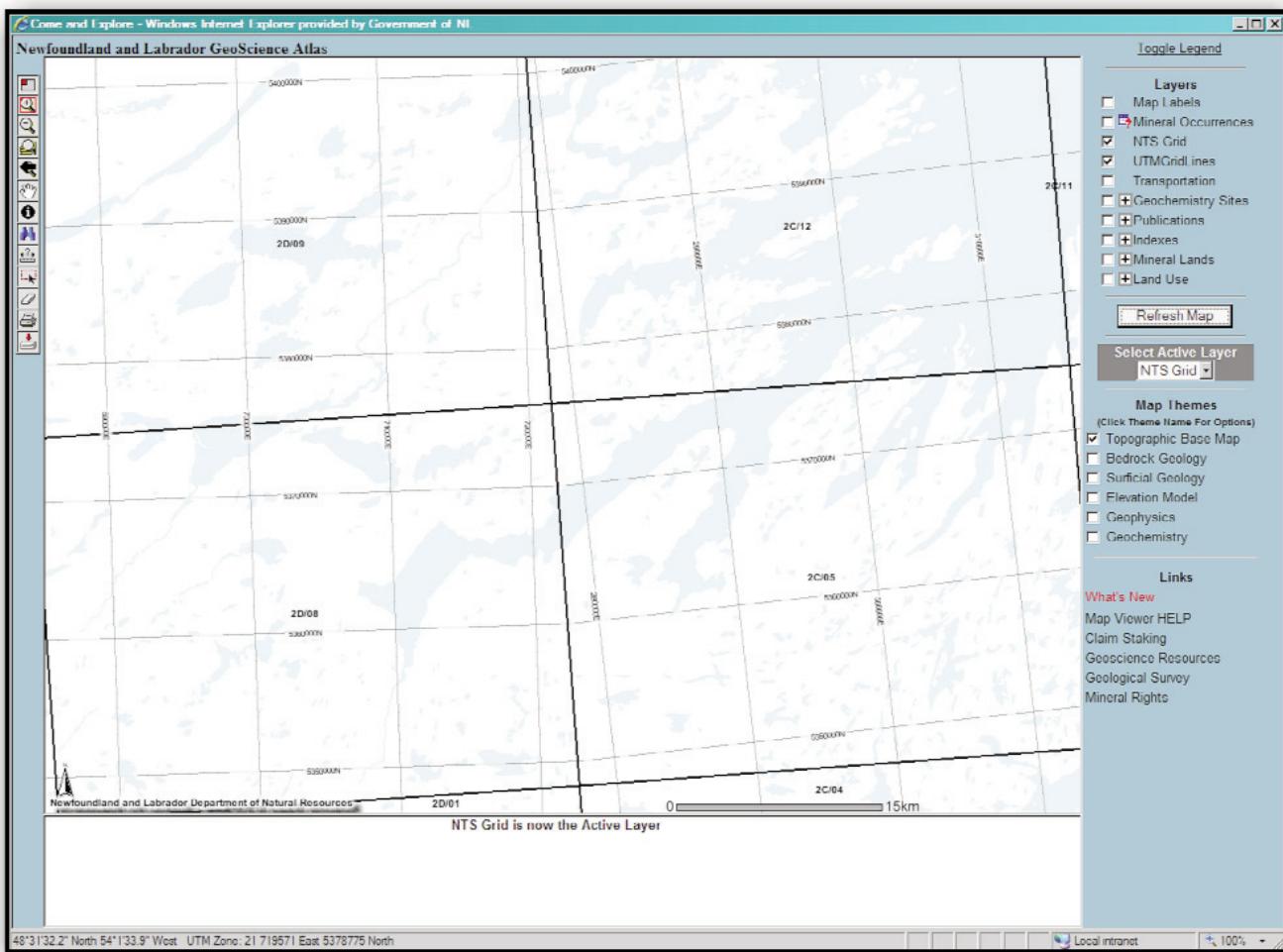
**Land Use Data:**

*Forest Access Roads*  
 Labrador Inuit Lands (LIL)  
 Labrador Inuit Settlement Areas (LISA)  
*Public Water Supplies*  
 Municipal Boundaries  
 Planning Areas

model). A few of the regional geoscience layers are complete and are not expected to change (e.g., regional lake sediment geochemistry, bedrock and surficial geology, aero-magnetic geophysics). Most of the other geoscience layers will be updated on a regular basis when new data or older compiled data become available (e.g., till geochemistry, plutonic and volcanic geochemistry, detailed bedrock and surficial geology). Two of the Atlas' databases are updated on a daily basis. The *Mineral Occurrences* layer is updated every evening with new information added that day, or information that has become non-confidential that day. The *Mineral Lands – Map Staked Claims* layer is updated in real time as new claims are staked on the 'MIRIAD' system.

Recent additions to the Atlas consist of a *UTM Grid Line* layer and a surficial *Landform* layer. The *UTM Grid Line* layer displays a NAD27 UTM 1 kilometre grid when the map view is zoomed in to scales larger than 1:275 000 (Figure 3). This UTM layer will be especially helpful in locating the positions of 500 m claim blocks when staking claims using the 'MIRIAD' system; claims are staked by selecting a 500-m square claim block that is *bounded by one corner of the NAD27 UTM 1km grid square* (Claims Brochure at [http://www.nr.gov.nl.ca/nr/mines/exploration/claimstaking/maintenance/claims\\_brochure.pdf](http://www.nr.gov.nl.ca/nr/mines/exploration/claimstaking/maintenance/claims_brochure.pdf)). The *Landforms* layer will be included in the *Surficial Geology* map theme. It provides locations of glacial features such as crag and tail formations, drumlins, and moraine ridges.

Existing geoscience layers that have recently been updated consist of the geochemistry layers *Till* and *Plutonic Sites*, *Airborne Surveys* index, and the surficial geology *Striations* and *Aggregate* layers. The *Till* geochemistry database has been updated with samples collected along the roads of the Avalon Peninsula in 2008 and 2009. The *Plutonic Sites* layer, formerly named the *Granitic Sites*, consists of a database of almost 5000 samples with field descriptions and geochemistry. It has been reorganized and standardized. The associated help file provides a description of the database as well as a list of references and selected bibliography. The *Airborne Surveys* index has many new exploration airborne surveys for both Newfoundland and Labrador. This includes the recent northwest Labrador survey from the federal governments *Geo-mapping for Energy and Minerals* (GEM) program ([http://gsc.nrcan.gc.ca/gem/index\\_e.php](http://gsc.nrcan.gc.ca/gem/index_e.php)). Hyperlinks in the *Airborne Surveys* index attribute table for the GEM survey provides further links to the digital 1:50 000 pdf maps of 10 different geophysical survey data, such as maps of uranium/thorium ratios and magnetic residuals. In the *Map Theme - Surficial Geology* section, the *Striation* database has been updated with data from sites visited in 2009. And in the *Links* section, the *Map Viewer HELP* file has been rewritten to provide a more detailed description of the Geoscience Atlas tools, as well as a brief description of



**Figure 3.** The new UTM Grid Lines layer, along with the UTM East and North labels, are based on the NAD27 datum and the zone they occur in. The grid lines will automatically display when the scale is larger than 1:275 000.

all available layers. Overall, there are more hyperlinks to available digital data, maps and help files.

## STANDARDS

The Geoscience Atlas is being provided to an international clientele, where English may not be their first language. With this in mind, the geoscience databases will be reviewed with an eye to standardizing the terminology and being more explicit where possible. For example, the term *NTS* is an acronym for the National Topographic System; a Canadian federal government system for numbering maps. Replacing it with a more descriptive term such as *NTS Map* provides the necessary information to the international client that it has something to do with map designations. The longer term *NTS Mapsheet* would be more appropriate except that it exceeds 10 characters, which is a limit when using older *dBase* systems.

The widespread use of GPS data is demonstrating the inaccuracies and distortions inherent in the old provincial topographic base maps, based on the NAD27 datum. The new CanVec 1:50 000-scale topographic maps (<http://ftp2.cits.rncan.gc.ca/pub/canvec/>) produced by the federal government are based on the more accurate NAD83 datum (Budgell and Ingram, 1991). The CanVec data are from the best data sources available, including new road and hydrographic networks. The new road data has an accuracy of 10 m or better (NRC, 2010). Much of the CanVec data is a realignment of the old NTDB 1:50 000-scale data using orthorectified Landsat 7 satellite images. This removes many distortions that were inherent in the older topographic maps.

When the Geoscience Atlas upgrades its base topographic maps to the NAD83 CanVec basemaps, features will appear to have shifted relative to other features compared to

the old data, but will be inherently more accurately positioned. This will be evident when plotting data locations from accurate GPS devices. The Geoscience Data Management Section of the Geological Survey will be providing information to help our clients adjust to the new datum and topographic base maps. The help file in the Topographic Base Map options box link will provide information on these issues.

As of 2009, upgrades to *ArcIMS* were discontinued by *ESRI*. In the next few years the Newfoundland and Labrador Geoscience Atlas will be redesigned for the third time to keep up with the changing internet mapping technology. The next generation of *ESRI* internet mapping software, *ArcGIS Server*, has many new capabilities and services including ready access to raster images, larger datasets, cached datasets, more complex queries and support for mobile devices and tablets.

## ACKNOWLEDGMENTS

The Geoscience Atlas would not have been developed without the vision, guidance and support of Peter Davenport and Larry Nolan. Harj Missan, Keith Parsons and Joe Atkinson are recognized for their support of the Geological Survey's Computer Unit in the early days of compiling digital data, which has served as the basis for the Geoscience Atlas.

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