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RECLAIMING GEOPHYSICAL DATA FROM MINERAL-ASSESSMENT REPORTS: AN UPDATE

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ABSTRACT

Geophysical information from mineral-assessment reports submitted over the last 40 years is being digitized, processed and organized as a database. Priority has been given to extensive airborne surveys. The processed data from these generally high-resolution industry surveys complement the regional survey data collected by government agencies by providing a significantly higher level of detail for the definition of geological structure. The industry surveys are commonly located in areas of perceived higher mineral potential.

A digital index, describing all airborne surveys flown in Labrador, has been extended to include such surveys in Newfoundland and a field has been added to the index database to indicate whether the data from each survey exists digitally. The digital index will provide a link to the digital geophysical database, thereby allowing readier access to it and promoting its use. The data comprising the digital index for Labrador and the digitized geophysical information from a survey area in Labrador have been imported into a data query and display program, which operates in the Windows® operating system on a PC.

Several advances have been made to improve the digital acquisition of geophysical data, database design and interrogation, and presentation of results. These include: upgrades to a suite of programs for digitizing data; installation of a flexible database query and display utility on both the PC- and mini-computer platforms; and installation and set-up of a large format electrostatic colour printer for the production of colour maps up to E-size.

The first in a series of entirely digital geophysical data reports has been released. The conversion to digital format of geophysical information of suitable quality from all other reports pertaining to Labrador is nearing completion. The digital capture of geophysical data from surveys in Newfoundland has also commenced with the data from three assessment reports already input. The processing of data from these surveys for release in the digital series is currently in progress.

INTRODUCTION

This project was initiated in 1991/92 to build a well organized, computer-processable geophysical database for the province to support mineral exploration and other geoscientific programs. To ensure its greatest possible use, an integral digital index was recognized to be an essential component of database design to allow very easy access to specific information.

The importance of constructing a digital index as a first step in the organization and distribution of geophysical information has been previously discussed (Kilfoil and Honarvar, 1992). On a basic level, the digital index would provide information on the spatial distribution of the various datasets comprising the database and facilitate queries to bibliographic information extracted from GEOSCAN (Patey and Gillespie, *this volume*), such as data source, ownership, and status. When fully developed, however, the digital index should also become the tool for navigating through the database to the actual survey data of interest. Although the digital index and geophysical database are physically distinct entities, they would be packaged as a unit for distribution, and the transition from index to database queries would be transparent from the user's point of view.

The Digital Index Design

The database file, which forms the basis of the digital index of all airborne geophysical surveys conducted in Labrador, has been upgraded to include a data status field. The status field describes the quality of the geophysical survey and whether the data currently exists in digital form or can be reasonably captured digitally. Therefore, the status field will change as information is scanned or digitized and/or processed for release as Open Files and inclusion in the geophysical database. As an example of a digital index query, Figure 1 shows all known airborne surveys in Labrador, with polygonal survey outlines coded by data status.

The outlines of airborne geophysical surveys conducted in Newfoundland for mineral-assessment reports and Geological Survey of Canada (GSC) surveys have been digitized. Figure 2 shows the boundaries of airborne geophysical surveys having non-confidential status, from all

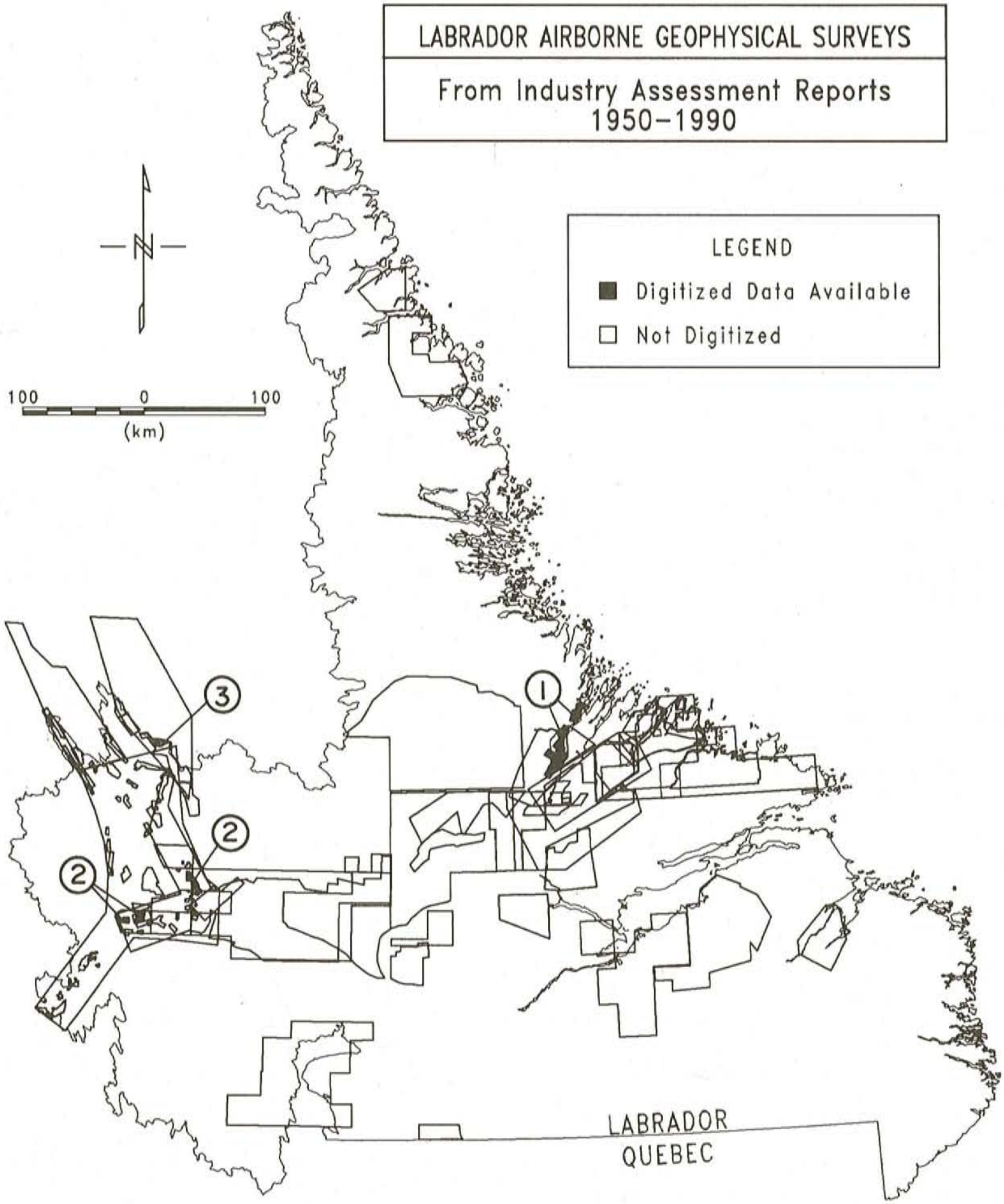

Figure 1. *Index map of airborne geophysical surveys conducted in Labrador between 1950 and 1990. Surveys for which geophysical data were input digitally are shaded. Digital data also exists for many of the smaller survey areas in western Labrador. Outlines of the regional GSC aeromagnetic coverage are not included as coverage is complete for the province. The map was output from a digital map index database, which also contains selected bibliographic information fields extracted from the GEOSCAN database. Numbers refer to survey areas discussed in the text.*

sources, reported within insular Newfoundland to 1990. Excluded from this diagram are the aeromagnetic surveys conducted by the GSC during the 1950's to 1970's, as these data form complete coverage of the province. Here, survey outlines are distinguished by their source, i.e., government or industry and surveys for which data were input digitally are shaded.

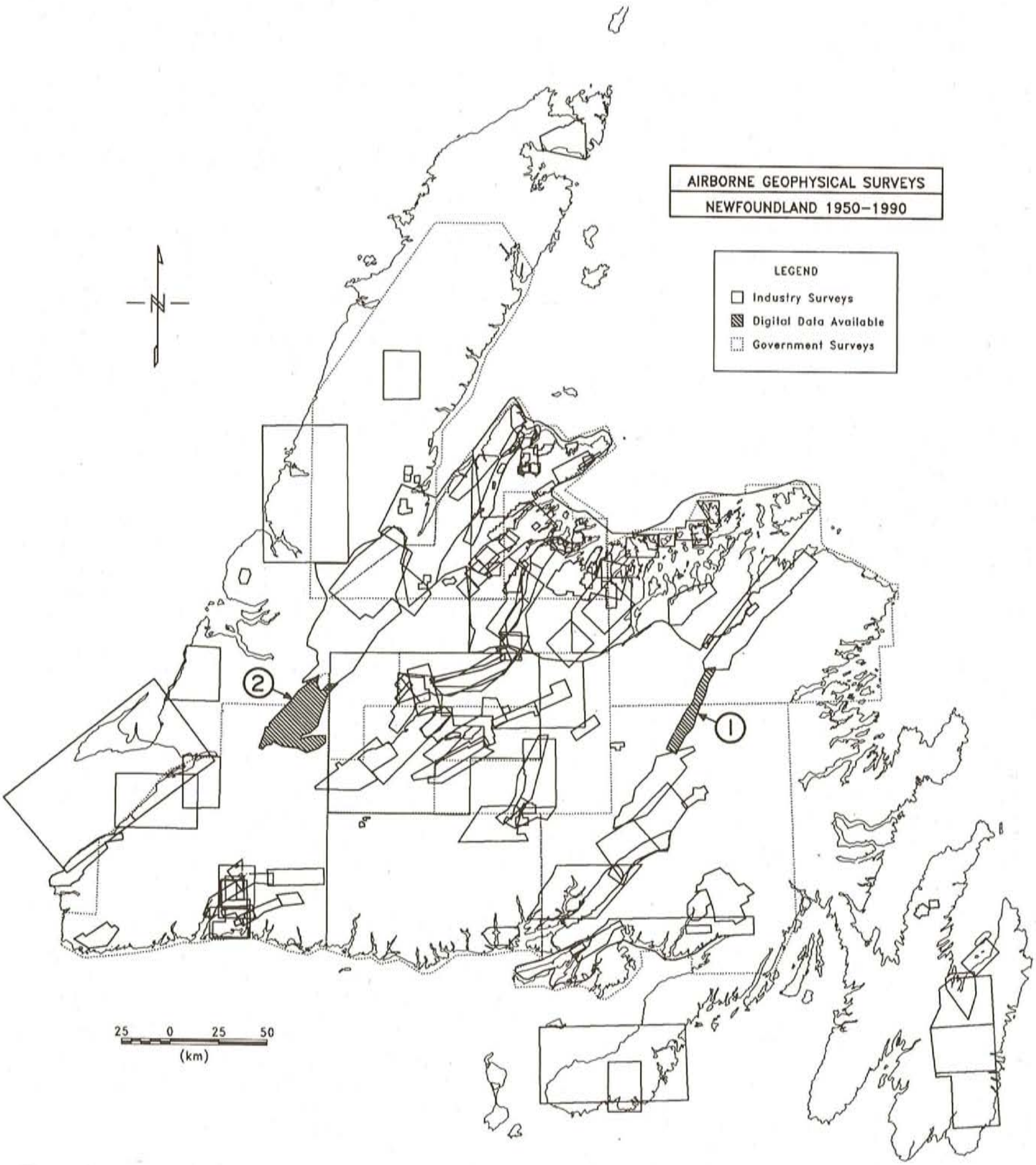

Figure 2. *Preliminary index map from the digital index of airborne geophysical surveys conducted in Newfoundland during the period 1950 to 1990. Surveys are differentiated by line types only on the basis of their government or exploration-industry data sources. Outlines of the regional GSC aeromagnetic coverage are not included on this map. The map is preliminary as the survey outlines have not yet been checked or associated with bibliographic information from the GEOSCAN database. Numbers refer to survey areas discussed in the text.*

Capturing Digital Data from Mineral-Assessment Reports–Progress to Date

The relative merits of digitally capturing geophysical data by optically scanning and digitizing methods have previously been discussed (Kilfoil and Honarvar, 1992). Experience has shown that large maps can be optically scanned at low cost and significant savings in time. However, the disadvantages of scanning are that the output is very sensitive to the quality of the map being scanned and extensive editing may be required to extract only the map information that relates to the data. Since much of the geophysical data that exists in submitted assessment reports is plotted on photomosaic bases where the grey-scale tones vary widely, digitizing these data is the only viable option.

Labrador

The geophysical data extracted from a geophysical survey of the Florence Lake greenstone belt (area 1, Figure 1) (BP Minerals Ltd. and Billiton Canada Ltd., 1983), have been digitized, processed and released as the first in a series of open files released in digital form (Kilfoil *et al.*, 1992). The release consists of: total-field magnetic values and total-field VLF-EM values in the form of binary grids at a 30 m resolution; a vector file of the locations and strengths of active EM anomalies, and vector files of digitized geological contacts, faults, dykes (Ermanovics, 1979) and flight-line paths. Using an upgraded version of program DISPLAY (Kilfoil, 1991), the gridded data in this release can be viewed on a PC equipped with a VGA monitor as shaded-relief images and the vector files can be overlaid for reference.

Geophysical data have been digitized for two other airborne survey areas in Labrador (areas 2 and 3 on Figure 1). These survey areas will be referred to here as the Labrador Trough (south) and Sims River areas; data were extracted from GSB reports (La Fosse Platinum Group Inc., 1987; Gulf Minerals Canada Ltd., 1981).

The data presented in the report covering the Labrador Trough survey was extremely clean and well-suited for digital capture. The helicopter survey was flown at low altitude and close line spacing. Although only 1:10 000-scale folded-paper copies of aeromagnetic contour maps, with EM anomaly symbols, were available for digitizing, the lines were crisp and uncluttered. The data plots for this survey were some of the few existing in the assessment-report library for which sufficient georeferencing coordinates for scaling were presented directly on data plots. When digitized magnetic data profiles were interpolated to a 20 m resolution, continuity of patterns in images generated from the resulting grid files showed that very little further data processing was required.

The methods of digital capture of data from the Sims River assessment report represented a unique challenge. Here, three areas were surveyed by two passes of a helicopter: the first pass recorded magnetic and active EM parameters, whereas the second pass recorded VLF-EM and gamma-ray spectrometric data. The results were presented as a series of stacked profiles, one for each flight line. Data from these profiles had to be scaled to maps of flight-line paths presented on a photo-mosaic reference, one set for each survey pass. In order to georeference data digitized from stacked profiles, the positions of flight lines were first determined by least-squares fitting of topographic features to plots of 1:50 000 digital topographic data, then the X-axes of the profiles were scaled to match the flight-line fiducials plotted on the maps and stacked profile plots.

The data from the Labrador Trough (Labrador Mining and Exploration Company, 1980, 1982) have been processed and its release as a digital open file is awaiting the completion of the digitizing of a geological map of sufficient detail for the area. The digital input of data from the the Sims River survey is also nearing completion. These two datasets are being released (G. Kilfoil and P. Bruce, unpublished data) in a manner consistent with the digital open file of the Florence Lake survey data.

Newfoundland

The polygons indicated by 1 and 2 on Figure 2 are outlines of the Gander Lake south and Glover Island airborne surveys. Locations of flight-line magnetic-contour intersections and active EM anomalies have been digitized from mylar plots included with the assessment reports submitted for these two areas, NTS map areas 2D(109) (Hudson's Bay Oil and Gas Limited, 1979) and 12A(214) (Hudson's Bay Oil and Gas Limited, 1978), respectively. The organization of these data for their release as digital open files is in progress and nearing completion.

As an experiment, gravity data collected during a ground survey from an exploration program for potash in the St. George's Bay area in southwest Newfoundland, 12B(147) (Hooker Chemical Company, 1971) has been captured. The data consists of Bouguer anomalies and elevations presented separately as postings and contours on very large 1:50 000 scale maps. Although positional references were plotted on these maps, the mylar copies were so faint that even the locations of several stations were barely visible. Thus, these maps would be impossible to scan. By careful study of stations relative to contours and cross-referencing, all stations were located, and the Bouguer anomaly and elevation values were typed into a listing with station number references. Station locations were digitized in piecemeal fashion and merged with the data listing to construct a datafile. Finally, since Bouguer anomaly values were referenced to an obsolete datum, the data were corrected to the 1967 International Gravity Formula (International Association of Geodesy, 1967), making possible their incorporation into the existing database for the province, as compiled by Energy, Mines and Resources, Canada.

Data Presentation and Distribution

Two developments during the last 12 months have significantly affected the approach to presentation and distribution of data being compiled as a geophysical database and linked digital index at the Geological Survey Branch.

First, to aid in the presentation of data, a large format electrostatic printer has been acquired and a software driver has been installed that generates maps up to E-size from Geosoft® grids and plots produced on the PC. The plotter is capable of resolutions up to 406 dots per inch and accepts a combination of HP-GL2 vector files and any of a number of compressed raster formats. Data may be ported via a RS-232 connection from a PC or through a HP-IB connection from any of the interconnected HP-700 series workstations via a LAN. When ported to the HP-700, early versions of the Gipsi™ (Paterson, Grant and Watson Limited, 1992) software (CPLOT_GEN and HP electrostatic driver) contained many bugs that prevented the plots from being generated effectively. However, after expending considerable effort in debugging the source code, the software is operational and several E-size colour-shaded-relief maps have been produced.

Second, on the data distribution and access side, a new query and display software package, ArcView™, has been released that appears capable of providing a successful link from the digital index to digital geophysical databases, graphical images produced from datasets and vector files of related georeferenced information (i.e., digital topography, geology). Licences for ArcView™, a user-friendly interface to databases developed by ESRI-ArcInfo (Environmental Systems Research Institute, Inc., 1992), can be purchased for a variety of computer platforms. ArcView™ has been installed both on the HP 9000/700 series UNIX-based workstations, operating in the X-Windows environment, and on an IBM-compatible PC, under the Windows® (Microsoft Corporation, 1992) operating system. In either case, ArcView™ takes advantage of the multiple windows and convenient, mouse-controlled point-click-drag features available in these environments to access database information.

When the data are properly organized, ArcView™ allows the user to simply select data layers for display from a menu. These data layers may be images, such as those generated from gridded aeromagnetic data; polygons, such as drainage basins or geological units; vectors, such as geological contacts or outlines of claims, surveys or lakes; or point data, such as sites of gravity stations or geochemical sample sites. All data are co-registered to a single coordinate system in order to properly overlay them and the coordinates of the current cursor position within a data window are displayed in the upper left corner of the screen. The properties, such as colour and line weights, of each data layer may be controlled interactively and, for point data, various symbol sizes or types can be chosen based on data values or classes at each site. In addition, when a particular polygon, vector or point layer is turned 'on', the dBase® database file upon which that layer is based can be queried by pointing to a particular entity on the screen and double clicking the mouse. Although ArcView™ is not a true GIS system, selective logical queries to the database file are possible. For instance, all geochemical samples from a particular database having gold concentrations above a certain threshold may be highlighted on the display. Several windows constructed from different combinations of datasets may be displayed simultaneously. A combination of overlays and windows may be saved as a 'view' that can be retrieved quidkly and easily.

To evaluate the effectiveness of ArcView™ in displaying information from the geophysical database, several datasets were imported into the ArcView™ format: the digital index of airborne geophysical surveys in Labrador, vectors for lakes, streams and coastline from the 1:1 000 000-scale digital topography for Labrador and the digital open file of geophysical data from the Florence Lake survey. After choosing only the survey outlines and coastline from the menu of overlays, a particular survey of interest is quickly found by zooming to an area selected by the mouse. The index was constructed such that information for a desired survey is obtained by pointing to one of the polygon edges and clicking the mouse. If the index is turned 'on', the fields from the database file are displayed in a new window. Although not included yet, one of the fields of the database could contain a list of views that, when selected, would display the data for that particular survey.

Since views can be assembled from a variety of data sources in ArcView™, new datasets can be included in a database as they are constructed, even though the datafiles may exist in several directories. New information is included in the current view by simply selecting the add function from the file menu and identifying the location of the new files. As a dataset is imported, its icon is added to the selection menu. The advantages, in terms of constructing the digital index and linked geophysical database, are that the geophysical database can be assembled as further information is digitized from assessment reports and the methods of linking the database to the digital index can be changed as more powerful versions of ArcView are released or in response to requests from users to link to other digital geoscience databases that may be built in the future.

Processing of Regional Geophysical Data

Data from airborne magnetic surveys, for the province collected by the GSC, have been referenced to the national datum as part of a federal–provincial initiative to level all existing aeromagnetic data for eastern Canada. The levelling project is coordinated by the GSC. As a provincial contribution to the project, data profiles digitized from individual map areas were joined into continuous survey blocks and checked for erroneous data values.

A copy of the levelled, aeromagnetic profile data for the province was received from the GSC early in 1992. These aeromagnetic profile data have since been organized by rejoining adjacent flight lines to form a levelled dataset for the province. The data have been gridded to a 200-m-grid interval and are in a form suitable for their release as digital open files.

Radioelement concentration data from all available airborne gamma-ray spectrometer surveys in Newfoundland have also been processed and are available as gridded datasets on floppy diskettes at a 200-m-grid interval. Spectrometric surveys were flown under contract by the GSC and partially funded by federal–provincial mineral-development agreements. Data profiles were processed with a statistically based Adaptive Trim Mean filter (Kilfoil and Nolan, 1992) designed to eliminate data outliers, many of which are caused by variable attenuation of the gamma-ray signal during survey due to the distribution of water bodies and variable soil moisture beneath the aircraft.

CONCLUSIONS

Refinements are being made to the digital index of airborne geophysical surveys for Labrador. The outlines of such surveys for Newfoundland have been compiled and will be merged with Geoscan information to complete the airborne survey index for the province. The obvious next phase will incorporate at least the more extensive ground surveys into the digital geophysical index.

After completing the digital capture of geophysical data from the Labrador Trough and Sims River assessment reports, most of the airborne geophysical data for Labrador that is of sufficient detail to warrant incorporation into the geophysical index, either already exists digitally or has been digitized. The digitizing of data from airborne geophysical surveys from Newfoundland has already begun. Airborn geophysical surveys are more numerous and generally mo detailed in Newfoundland than those in Labrador. Thus completing the digital input of airborne survey information for Newfoundland is a considerably greater task.

In an initial evaluation, ArcView™, a PC-based data display and database query package, has been shown to have the necessary functionality to link a digital index of airborne geophysical surveys to a digitally captured geophysical dataset from a survey area; the task of determining the best method of constructing that link remains to be sorted out. The concept of assembling views from diverse datasets and the query capabilities give ArcView™ the necessary flexibility to design a comprehensive geoscience database.

To date, the processing and release of government-sponsored geophysical datasets have been largely demand-driven. However, the entire levelled, aeromagnetic profile data (from the GSC) for the province have been gridded to a 200 m interval and is ready for release in digital form. The 200-m-grid resolution approaches the lower limit of that possible with data digitized from 1:63 663- and 1:50 000-scale contour maps (Kilfoil, 1990).

Despite the sensitivity of recorded gamma-ray spectrometric data to water bodies and soil moisture within the area of influence, the results of a first attempt at removing these effects from data recorded during airborne surveys in Newfoundland by statistical methods have shown that significant detailed geological information can be extracted. The data corresponding to radioelement concentrations could be more effectively corrected by incorporating the distribution of known bodies of water within the areas influencing the sensor beneath each record location. Since digital topographic information is currently available for the entire province at 1:250 000 scale and at 1:50 000 scale for several map areas in Newfoundland, a knowledge-based filtering algorithm could be written to incorporate this information. Results from such filtering should yield a stronger geological signal discrimination than could be achieved using statistics alone. Following these corrections for bodies of water, a similar filtering process could be employed to correct for the variable distribution of surficial deposits, which have also been shown to attenuate the gamma-ray signal and which are being mapped to increasing detail in the province.

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