GOVERNMENT OF
NEWFOUNDLAND AND LABRADOR
Department of Mines and Energy
Geological Survey

GeoLegend Version 2.0 for Macintosh

USER'S MANUAL

S.P. Colman-Sadd

OPEN FILE NFLD/2650
Version 2.0

St. John's, Newfoundland
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Recommended citation:

Colman-Sadd, S.P.

2003: *GeoLegend* Version 2.0 for Macintosh. Newfoundland and Labrador Department of Mines and Energy, Geological Survey, pages 170. Open File NFLD/2650, Version 2.0.

CONTENTS

FIGURES

WHAT IS GeoLegend?

GeoLegend is a database designed to:

1. organize information that describes bedrock geological map units, and

2. use this information to control the representation of map units on geological maps and legends output from Geographic Information Systems (GIS).

The basic information stored in *GeoLegend* is usually derived from existing geological maps. These maps may have been published at a variety of scales, over extended periods of time, and have incompatible legends and labelling schemes.

Polygons, lines and points representing units on maps in a region are keyed to *GeoLegend*, which is then able to organize the geological data so that the user can produce, from a single set of linework, the following:

1. A map showing a selected level of geological detail, which can vary from the level of detail actually digitized, through ten levels of generalization, to the level commonly employed for regional lithofacies or tectonic assemblage maps at scales of 1:1 million or less. This flexibility allows production of maps with geological detail that can be varied both between maps and within maps and is appropriate to any scale or use.

2. A map that has a usable degree of internal consistency, even though it may overlap boundaries between different topographic or geological map areas.

3. Alphanumeric unit labels that are consistent within the map and with other maps produced by *GeoLegend*, and which reflect the level of geological detail selected by the user.

4. A list-style legend that: (a) includes all units that are present in the selected area, at the selected level of detail, and no other units, (b) gives standard descriptions of the units on the map, at the selected level of detail, along with appropriate titles for age, stratigraphic classification, tectonic division, and rock class, and (c) organizes and orders units according to age, tectonic division, rock class, or some combination of the three, at the option of the user.

5. A data listing that can be imported into any database as a flat file to allow searches for units based on age, stratigraphic classification, tectonic division, rock class, lithological keywords, and other variables.

6. A list of references for the linework depicting map units and the legend descriptions for the selected area, and only the selected area.

The *GeoLegend* References table also allows output of bibliographic data in formats suitable for publishing map catalogues on paper or online.

SYSTEM REQUIREMENTS

HARDWARE

Apple Macintosh™ computer or equivalent, preferably equipped with a PowerPC™ CPU. The sizes of windows and forms are preset for display on a 17 inch monitor and some difficulty may be encountered if a smaller monitor is used. *GeoLegend*, as published, occupies 28 Mb of hard disk space, but this will change if the contained data are replaced; the database structure alone occupies about 8 Mb.

Published version □ actually occupies □ about 17 Mb

GeoLegend is also available for the Windows™ operating system using the Microsoft Access™ database package.

SOFTWARE

GeoLegend was prepared using the Helix RADE 5.1™* database package. It can either be used with this package or as a stand-alone application.

INTERFACE

GeoLegend uses text files to interface with the graphical components of a GIS, so it is independent of the GIS package used or the platform on which this software is run. Text files of data lists are formatted for the Windows™ operating system, with both carriage returns and line feeds for end-of-record markers.

Conversion of text files between Windows, Macintosh and UNIX platforms can be done by globally changing the carriage returns and line feeds on a word processor, but is most easily accomplished using the freeware utility, TextToMac 1.32, available for download from FTP archives, such as *http://hyperarchive.lcs.mit.edu/*.

* May be purchased from Helix Technologies, 4870 Viewridge Avenue, San Diego, CA 92123, U.S.A. Tel. and Fax: (516) 935-9151, or through the Helix website at *www.helixtech.com*

Legends and reference lists are output as text files, which can be formatted automatically in Microsoft Word for Macintosh™ using the Applescript™ and Word™ macros in Appendices 2 and 3. An Adobe Acrobat™ version of this manual is available and allows the scripts and macros to be copied and pasted directly from the appendices.

RELATED SOFTWARE

Version 2.0 of *GeoLegend*, as published, contains a dataset for western and central Newfoundland. This dataset provides an example of how data should be entered, and allows data files to be output immediately. The dataset corresponds to graphical files in Open File NFLD/2616, version 4.0 (Colman-Sadd and Crisby-Whittle, 2002) and can be used in combination with these files to produce customized geological maps of parts of western and central Newfoundland.

One of the objectives for *GeoLegend* is that it be compatible with the North American Data Model (NADM) (Johnson *et al*., 1999) and the Canadian Geoscience Knowledge Network (CGKN) (Broome, 2001). Generally, data from *GeoLegend* can be imported into the NADM. However, the structure of the latter is not yet finalized so incompatibilities will inevitably arise. It is intended to resolve these whenever they are identified.

INTRODUCTION

THE PROBLEM

What is a Map Unit?

The most obvious feature of a geological map is the division of the mapped area into smaller areas, each underlain by a distinguishable geological unit, a map unit. Each unit is labeled on the map and the label can be referred to a legend, which provides information about the rocks that underlie that particular area, such as a lithological description, age and stratigraphic classification.

Most map units cover sufficiently large areas on the ground that their boundaries, when plotted on a map, define two dimensional polygons. However, some map units, such as dykes, are too narrow to have their widths shown on the map and are indicated by lines. Other map units consist of single exposures and are depicted as points. Whether the map unit is represented on the map by a polygon, a line or a point, it always refers to a particular kind of rock or rock assemblage that a geologist found to be distinguishable from other rocks in the area. It is distinct from some of the other features

shown on a geological map, such as structural measurements, mineral occurrences, isograds or faults.

Criteria for Defining Units

The classification of rocks into map units is a subjective process. Some important factors that influence it are as follows:

1. The tendency of an individual geologist to "split" or "lump" rock types.

2. The preconceived ideas of a geologist concerning the significance of particular lithological contrasts.

3. The pre-existing stratigraphic classification of the rocks.

4. Regional and global geological theories current at the time of mapping.

5. The scale of mapping.

Because of this subjectivity, systems of map units are seldom compatible on adjacent map sheets prepared by different geologists, and quite often are incompatible between areas mapped by the same geologist.

Unit Labels

The labelling of map units is usually peculiar to individual map sheets. If a numerical system is used, units within an area are numbered from 1 upward and any compatibility with neighbouring maps is fortuitous. If an alphanumeric system is used, certain conventions may be followed, but few geologists try to use labels that match those on neighbouring maps.

Legends

The incompatibility of map units and unit labels from map to map means that a separate map legend must be compiled for each map and is only applicable to that map. This is so in a horizontal sense, between neighbouring maps of comparable scales, and it is also so in a vertical sense between maps of different scales for the same area. Small-scale, compilation maps are generally divided into less detailed units than large-scale maps and impose unit and labelling schemes that mostly differ from any of the schemes used on the more detailed source maps.

SOLVING THE PROBLEM WITH *GeoLegend*

GeoLegend organizes the information about geological units in a region so that all maps in the region have compatible labels and legends. In doing so, it allows maps to be automatically generalized, customized and searched within a GIS.

The organization of map units by *GeoLegend* starts with certain conventions that are more or less observed by geologists:

1. At detailed scales, map units are usually named and organized on a legend according to a hierarchical system of stratigraphy (North American Commission on Stratigraphic Nomenclature, 1983). Thus, a particular unit may be part of a Member, which is part of a Formation, which is part of a Group, which in turn is part of a Supergroup.

2. At less detailed scales, units tend to be organized along more interpretive lines into lithofacies or tectonic assemblages. These are assigned to tectonic divisions or rock classes or categories of some other kind, again in a hierarchical fashion (e.g., Williams, 1978; Colman-Sadd *et al.*, 1990; Gabrielse *et al.*, 1991; Wardle *et al.*, 1997).

3. On many maps, unit labels are alphanumeric and the sequence of letter symbols often indicates, first the age of the unit, and then the stratigraphic entities to which the unit belongs in descending order through the stratigraphic hierarchy. Thus, the label 'OBSv' might indicate a volcanic unit (v) belonging to the Sandy Lake Formation (S) of the Buchans Group (B), which is of Ordovician age (O).

4. Map legends are generally ordered on the basis of some combination of age, stratigraphic classification, tectonic division, and rock class.

SYSTEM OVERVIEW

GeoLegend was originally designed for use on the Island of Newfoundland, Canada, an area mainly underlain by rocks of the early to middle Paleozoic Appalachian orogenic belt. More recently, it has been used to organize map units in a part of northern Labrador, where rocks of the Canadian Shield are mostly Archean to Mesoproterozoic. The following overview shows how *GeoLegend* has been used in these areas to integrate a variety of geological maps so that they can be used as a consistent whole within a GIS. Different users may want to vary this approach to suit their own needs. The system consists of two components, the graphical component of the GIS, which contains the linework, and *GeoLegend*, which contains the geological data.

GRAPHICAL COMPONENT OF THE GIS

Two Sets of Digital Maps

The objectives for Newfoundland and Labrador have been to produce two sets of digital map coverage. These are:

1. Maps stored as individual digital files. These maps collectively provide comprehensive coverage for the region. In many cases, the maps overlap and so there may be more than one map available for a particular locality, and usually the geology shown on the overlaps is different on the different maps. Maps that are deemed to have been superseded by later work are not digitized.

2. A single map for the whole region. This map is a composite of the maps contained in the individual files and is made by joining the digital files for the individual maps in the GIS. Where source maps overlap, a decision is made as to which map most accurately depicts the geology for any particular locality and the maps are joined so that the "best" map is retained for any given locality. A secondary consideration is to minimize the mismatches between contacts across source map boundaries. The composite map is especially useful as a backdrop to other kinds of data, when the user may not want to, or may not be competent to, decide which geological map is "best" for a locality.

The "Best" Geological Map

The "best" map for a particular locality is the map that is most reliable and informative. In most cases, three considerations are paramount:

1. "How old is the map?" Usually the most recent map is to be preferred because it is likely to incorporate information found on earlier maps and then add any new information.

2. "What scale is the map?" *GeoLegend* allows a GIS to generalize a map. Therefore, there is no point in digitizing maps at several scales for the same area. Generally, the most detailed map available is preferred because it contains more information in terms of geological detail and subdivision, and contacts can be digitized with greater topographic accuracy.

3. "What was the main interest of the geologist?" Many maps focus on particular units, which are mapped in detail, while other units are only included for the sake of completeness. The peripheral units on one map may be the main units of interest on another map, and the latter map would therefore provide a better source for these units.

The "Authorized" Version

In most cases, the source map will have been published previously. If it has not, it should be published separately from the digital files so that there is a clearly identifiable, "authorized" version, which is entirely the work of the geologist(s) concerned and can be referenced.

Revisions to Source Maps

Linework

Linework is digitized exactly as shown on the source maps and its position and attributes remain unedited, even though this may cause mismatches across source map boundaries on the composite map.

The mismatches represent gaps and uncertainties in information about the geology. An attempt to remove them replaces the opinions of geologists in the field with the opinion of a compiler, who may never have been to the area. On a compiled map, the alteration of information is an acceptable trade-off for the greater readability of the map because its effect is minimized by the reduction in scale and detail on the final product. On a composite map, this is not so because the map will commonly be used at the same scale and detail as the source maps. Mismatches should be viewed as a source of information in themselves. They convey a sense of the uncertainty of the geological information in an analogous way to error estimates provided with radiometric dates. Mismatches can be edited on customized maps derived from the composite map.

Labels and Legends

Unit labels are discarded and replaced by unique polygon identifiers. These are keyed to geological data in *GeoLegend*, which are used to replace the labels and legend on the source map. In this way, labels and legends can be made consistent from one map to another.

Units cross source map boundaries and therefore the description and classification of a unit on one map may be superseded on a later map. The data in *GeoLegend* represents the most current information available for a unit. In the process of reclassifying units, it is critical that only units that are truly equivalent are entered into *GeoLegend* as equivalent. If in doubt, units should be treated as distinct.

Joining Maps

Joining maps is subject to two considerations:

1. Any given locality should have the best depiction of the geology possible.

2. Provided item 1 is not compromised, the join should be placed where it minimizes mismatches of contacts across source map boundaries.

Figure 1 illustrates an area where two overlapping maps are available for an area. Map NF013 has the most detail in the south of the area and Map NF021 in the north. Units 8 and 20 are equivalent, as are units 6a and 14. The contact between units 8/20 and other units appears to be drawn in most detail on Map NF013. The join line is placed so that it preserves the most intricate parts of the unit 8/20 contact and salvages the best part of each map. In order to minimize mismatches it has been drawn entirely within units 8a/20, 6a/14 and 8b/20. The join line passes from one unit to the next at the two points where the contacts between units 8a and 6a, and 6a and 8b, on Map NF013 most closely coincide with the boundary between units 20 and 14 on Map NF021.

Polygon Identifiers

Each polygon, line or point representing the occurrence of a map unit (henceforth referred to collectively as polygons) is assigned a unique identifier. The identifier has two parts, the number of the source map within the region, and the number of the polygon within that source map. An example is NF213_0004, which is the identifier for the fourth polygon in map number 213 in Newfoundland. The identifier is the link with the *GeoLegend* database.

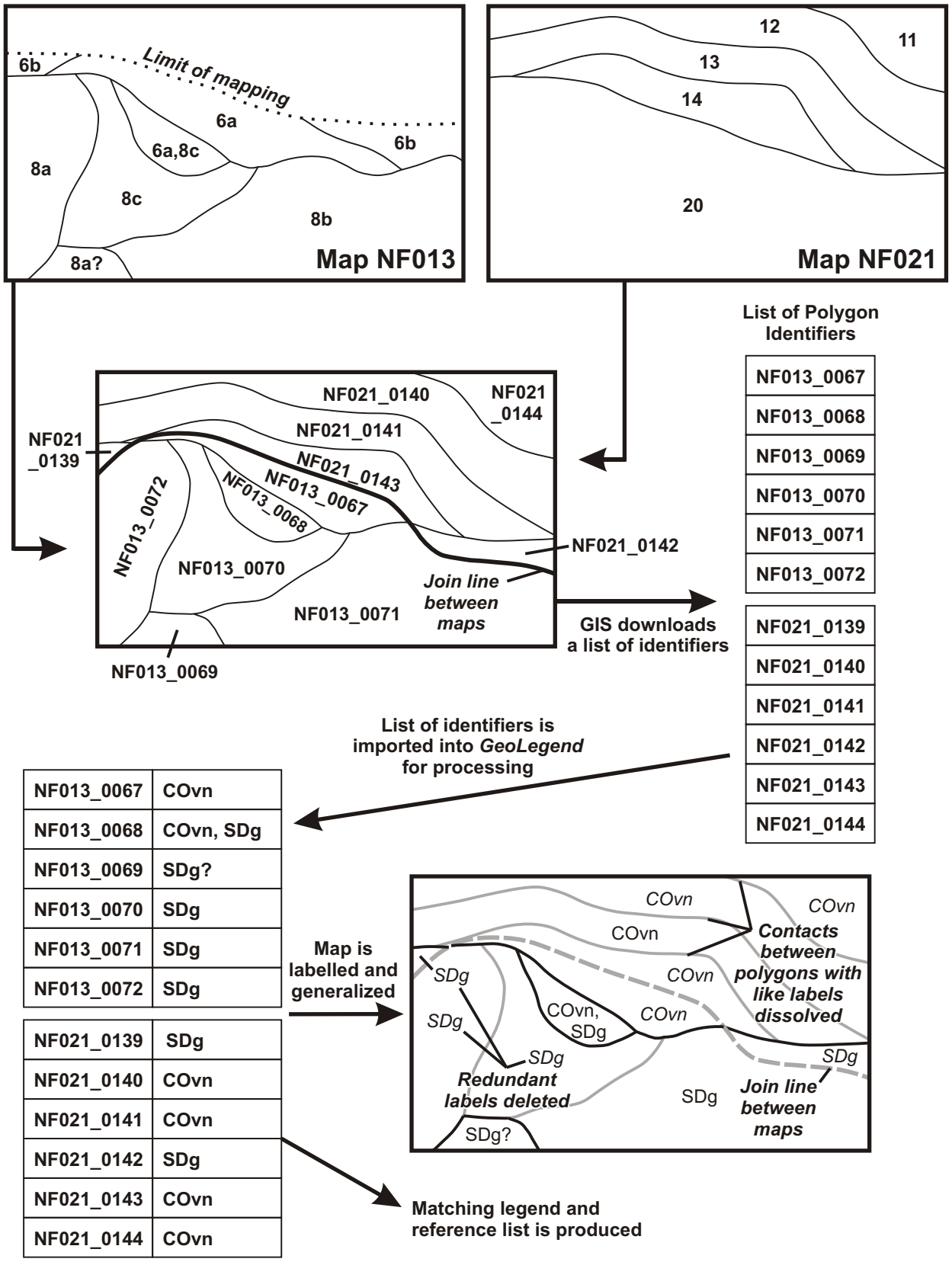

Figure 1. *Basic procedure for identifying polygons, joining maps, and relabelling maps using* GeoLegend *(after Colman-Sadd* et al.*, 1997).*

DATA COMPONENT: ***GeoLegend***

Reclassification of Map Units

GeoLegend contains a list of the unique identifiers for all the polygons in the mosaic of maps. For each polygon, it also contains the unit label that was assigned to the polygon on the original, published map. Thus, on map NF013, polygon 67 was originally labelled as Unit 6a, which was shown on the legend for that map as a volcanic mafic breccia belonging to the Sandy Lake Formation of the Buchans Group. Unit 6a has no meaning outside the context of this particular map and legend, and the same package of rocks was labelled as Unit 14 on map NF021 (Figure 1).

The first procedure in the database is to reclassify the original map units according to schemes that are compatible from one map sheet to another. Three different classification schemes can used allowing three different types of maps to be produced:

1. For the production of detailed maps, the classification scheme is based on the stratigraphic code. Each unit is classified in terms of its supergroup, group, formation, member, and four levels of subunits for unnamed subdivisions. Non-stratified units are classified using the equivalent lithodemic ranks (North American Commission on Stratigraphic Nomenclature, 1983). For Unit 6a on map NF013, 'Buchans Group' and 'Sandy Lake Formation' are entered in the group and formation fields respectively; 'v' for volcanic is entered in the sub1-unit field, 'm' for mafic in sub2-unit, and 'x' for breccia in sub3-unit. The supergroup, member and sub4-unit levels in the classification are not specified and the fields are left empty in the database.

2. For the production of small-scale lithofacies or tectonic assemblage maps, the classifications are based on the units shown on small-scale compilation maps for the region. In the case of Newfoundland, the principal map of this kind is the 1:1 million bedrock geology map of insular Newfoundland (Colman-Sadd *et al.*, 1990). Although the divisions on this lithofacies map do not use stratigraphic names and are not compatible with the stratigraphic code, it is a simple matter to reclassify a map that is based on the code in terms of lithofacies units. Unit 6a on map NF013 is assigned to unit 'COvn' (for Cambro-Ordovician volcanic rocks of the Notre Dame tectono-stratigraphic subzone). *GeoLegend* allows the entry of two different regional classifications, one in a "lithofacies" table and the other in a "tectonic assemblage" table. The structures of the two tables are identical but the data entered into them would normally be different, allowing the production of thematically different regional geology maps from the same underlying data.

Relabelling of Map Units

Once map units have been reclassified under schemes that have universal application, they can then be relabelled in ways that are consistent from one map sheet to another. Two methods of relabelling are used to correspond to the detailed and regional reclassification schemes:

1. Detailed maps use an alphanumeric system similar to that commonly found on Geological Survey of Canada maps. The first part of the label indicates the age of the map unit, which is derived from information previously entered into the database specifying the age of the top and base of each unit. The age part of the label, for which a special font would be used on final maps, is followed by a colon and then by letters indicating the various subdivisions of the stratigraphic hierarchy to which the unit belongs. The label for Unit 6a on map NF013 is 'O:BSvmx', where 'O' stands for Ordovician, 'B' for Buchans Group, and 'S' for Sandy Lake Formation; the subunits use the same characters as were used in reclassifying them. The letter, 'B', is assigned to the Buchans Group independently of any map sheet and is generated as a part of the label for any unit that is classified as belonging to the Buchans Group, no matter where it occurs. Similarly, the letter, 'S', is always used for units classified as part of the Sandy Lake Formation (of the Buchans Group).

2. Small-scale lithofacies and tectonic assemblage maps use the labelling schemes on the compilation maps for the region, in this example 'COvn'.

Basic Procedure for Generating a Map and Legend

1. The user selects an area in the region for which a geological map is required. Either a map can be chosen from the archives of individual map files, or a portion of the composite map can be selected. In the latter case, the area does not need to conform to topographic map boundaries or boundaries between published geological maps.

2. The GIS makes a copy of the individual file or extracts a copy of the part of the composite map that lies within the selected area and uses this template to produce the map.

3. The GIS lists all the polygons within the selected area, identifying each one uniquely by its polygon identifier (e.g., NF013_0067) (Figure 1).

4. The polygon list is imported into *GeoLegend*.

5. The user instructs *GeoLegend* to produce either a regional map (lithofacies or tectonic assemblage) or a map based on the stratigraphic hierarchy; if the latter is selected, the user also specifies the level(s) of detail (*see below*).

6. *GeoLegend* determines standard unit labels for all the polygons and produces a text file containing a list of these labels attached to their respective polygon identifiers.

7. The polygon and label list is imported into the GIS and unit labels placed in the appropriate polygons. The map can now be generalized (*see below*) and coloured using the unit labels as a guide.

8. *GeoLegend* constructs a legend for the units represented on the polygon list, at the correct level(s) of detail, using previously entered descriptions and other necessary information. The legend is exported to a text file, which can be automatically formatted as a Microsoft Word™ document by the scripts in Appendices 2 and 3.

9. The database lists references to publications used as sources of line work or legend descriptions. The list is exported to a text file, which can also be formatted as a Microsoft Word™ document and then appended to the legend by the scripts in Appendices 2 and 3.

10. The files for the legend and references are imported into GIS or other cartographic software for insertion alongside the map.

Level of Detail

Variation Between and Within Maps

GeoLegend can produce maps and corresponding legends at ten levels of detail and the level of detail can be different for different units on the same map. For instance, a geological map may show units of the Buchans Group and the Topsails Intrusive Suite, the former divided into formations which in turn are divided into lithological subdivisions, and the latter into separate intrusions that are divided into phases. *GeoLegend* could be instructed to produce a map in which the Topsails Intrusive Suite is undivided, the Buchans Group is divided by formations, and a particular lithological subdivision, perhaps a mafic volcanic breccia, is picked out from the formation in which it occurs.

Generalizing to Produce a Regional Map

The user of *GeoLegend* has an initial choice between a regional map (lithofacies or tectonic assemblage) or a map based on the stratigraphic hierarchy. If the lithofacies map is chosen, each polygon is given the appropriate label from the regional lithofacies map for the region. This map is, by definition, very generalized; on the Island of Newfoundland, approximately 5000 stratigraphic units are expressed in terms of 57 lithofacies units. Therefore neighbouring units that would be distinguished from each other on a typical 1:50 000 scale map commonly have the same lithofacies labels. Once the labels have been assigned to individual polygons, the GIS compares neighbouring polygons and, if they have the same labels, as many of them will, it dissolves the contacts between them (if the contact is a fault, the fault is retained). The map is thus reconstructed into larger polygons that reflect the lithofacies level of detail.

Generalizing to Produce a Stratigraphic Map

If the user chooses to produce a map based on the stratigraphic hierarchy, a similar procedure is followed but there is more flexibility. Map NF021 may show two formations of the Buchans Group, the Sandy Lake Formation and the Lundberg Hill Formation; they consist of units 13 and 14, and 11 and 12, respectively (Figure 1). In the database, these units are reclassified using their group and formation names, and subunit characters to distinguish lithological divisions. If the formation level of detail is requested, *GeoLegend* generates unit labels 'O:BS' and 'O:BL', respectively, where 'B' stands for Buchans Group and 'S' and 'L' for the formation names; it ignores the subunit fields because these are below the level of detail requested. The labels are inserted into the appropriate polygons. When the GIS checks the polygon labels, it finds that the labels in polygons originally labelled 13 and 14 are the same and removes the contact. Likewise it removes the contact between the polygons originally labelled 11 and 12, but retains the contact between the polygons that were labelled 12 and 13. The map is now generalized at the formation level.

If *GeoLegend* was instructed to show the Buchans Group as an undivided group, the database would truncate its classification of the units at the group level. It would then produce 'O:B' as the label for all the polygons originally labelled 11 to 14, and all four polygons would be merged.

Further, if *GeoLegend* was instructed to divide up the Sandy Lake Formation at the sub1-unit level, we might find that sub1-unit for Unit 13 was 's' for sedimentary and for Unit 14 'v' for volcanic. In this case, the polygons originally labelled 13 and 14 would now be labelled O:BSs and O:BSv respectively, and the contact between them would be retained.

SYSTEM REFERENCE

GETTING STARTED

Opening *GeoLegend*

Double click on the *GeoLegend* icon in the 'Finder'. A dialogue box is presented. Double click in the dialogue box where it says "Double Click to Open".

The 'Setup' Menu

The output procedures in *GeoLegend* have been automated using a series of macros. These macros require that the names of output files and the disks to which these files are exported are specified each time *GeoLegend* is loaded onto a different computer.

Go to 'Setup' on the menu bar and select 'Set names and destinations of output files'. Follow the instructions on the form. Note that this form can be used at any time to export specific parts of the dataset.

The setup procedure for the 'Web Map Index' only needs to be followed if this feature is actually going to be used.

Other Menus

Apple menu: 'About *GeoLegend*' provides author information, address, phone numbers and e-mail.

File: 'Save', 'Print', 'Export', and variations of these.

Edit: 'Undo', 'Cut', 'Copy', 'Paste', 'Select', and variations of these.

IMPORTANT

Set: 'Autosave' should be enabled because this allows more efficient data processing. If you do not want to be interrupted by 'Autosave', set the interval to the maximum (23 hours 59 minutes). 'Sort Order' presents a choice of sorting orders for certain forms.

View: Commands for moving from record to record in a table. Note that it is often easiest to find a record by double clicking it on a list form; this will open the entry form at that record. 'Enter' and 'Delete' commands are also present on this menu. Depress the option key and 'Enter' to enter a record without moving to the next record or a clear form. The 'Delete' commands are deactivated when entry forms are uppermost; they can be used with all list forms (*see* "Deleting Records", below).

Table: Provides access to the entry forms for the principal input tables and to the 'Output Selection' form.

Fields

On the entry forms, data can be entered into fields that have a white background. Depending on the entry field, data can be typed in, entered from a menu, or imported automatically, or some combination of these.

If the field is stippled, a default value will be entered if no other entry is made. The default may be provided by the last record to be shown on the form or by a calculated value.

Dark grey shading indicates empty fields that must be filled to allow entry of the record, or fields in which the entered value does not pass validation. Select the 'Why?' notice under the 'Apple' menu to find out what the problem is.

Fields that have a light grey background contain computed variables and data cannot be entered into them. All fields have a light grey background on list forms because these forms do not allow data entry.

Variable names are non-bold, Roman type for entry fields, non-bold italics for computed fields, bold Roman type for fields from which data are posted to other tables, and bold italics for fields that receive data by posting from another table.

Command Buttons

Buttons are colour coded:

Green: Opens the entry form for an input table or the 'Output Selection' form. In most cases, these buttons present the same choices as are available on the 'Table' menu.

Blue: Opens a query dialogue box for selecting particular records.

Lilac: Opens another form for the same table or opens a dialogue box, which allows some procedure to be activated.

Red: Activates a procedure directly without first presenting a dialogue box.

Deleting Records

Records can be deleted by selecting 'Delete', 'Delete All', or 'Delete Selections' from the 'View' menu. These commands are not available for entry forms because several of these contain subforms, which may cause the deletion of more records than intended. Deletion is always done using the 'List…' forms.

Data Integrity

Validation of Individual Fields

Certain fields have validation criteria that prevent the entry of obviously incorrect data. For example, letters cannot be entered into numeric fields and ages cannot be entered if they lie outside the age range of the Earth.

Validation is also used to maintain standards that might otherwise be ignored. An example of this is the requirement that a legend description always have an accompanying reference.

In general, validation is used sparingly because it can be an unnecessary nuisance during data entry and editing. Instead, *GeoLegend* relies extensively on retroactive error checks to maintain data integrity (*see* "Utilities", below).

Pop-up Menus

Menus attached to individual fields are used to enter values that have previously been entered elsewhere. For instance, a formation name should only be typed in once; after that it appears on a menu and should be entered from the menu. This method saves time and prevents typographic mistakes.

Limitations in the Macintosh operating system prevent more than 255 items being listed on a pop-up menu. If this results in items being omitted from a menu, it is recommended that you copy and paste them from an existing record rather than retyping them.

Utilities

Utilities, operated by command buttons, are used to check for several common kinds of errors, like duplicate records. They are also used to check on the integrity of the linking variables between tables. In most cases, these variables can be edited independently of each other, which allows for maximum flexibility, and the accuracy of the editing can be checked by the utilities retroactively.

Operation of *GeoLegend*

There are three parts to the process of producing *GeoLegend* maps:

1. The graphical component of the GIS: This must be setup in such a way that it interfaces correctly with *GeoLegend*.

2. The eighteen *GeoLegend* input tables: These contain information about geology, references and presentation for each polygon. Three of the tables require modification each time a new map is added to the system, and the others function mainly as look-up tables and require less frequent changes.

3. *GeoLegend* 'Output Selection': This is a form on which the user can select the map to be processed, the level of detail, and the kind of output required. Output of purely bibliographic data is done from the 'References: Entry form'.

Setting up *GeoLegend* for a New Region

Figure 2 shows how the various input tables in *GeoLegend* are related to each other. The tables and subsidiary tables for 'Lithofacies units', 'Tectonic assemblages', 'Summary rock-type keywords', 'Colours', 'Time scale' and 'References' are used to look up relatively static information. It is useful to enter most of the data required in these tables first, before entering data for individual maps in the 'Polygon IDs' 'Unit IDs' and 'Stratigraphic units' tables.

Deleting Data from Another Region

If you have a copy of *GeoLegend* that was used for another region, it will probably contain data for that region. The original published version contains data for a portion of central Newfoundland, which serve as an example of how data should be entered (*see* "Related Software", above).

The quickest way to delete old data is by using the 'Output Selection' form under the 'Table' menu. Click the button marked 'Import and REPLACE current dataset' (*see* Figure 14). Each time the dialogue box asks you to name a file to import, click 'Cancel'. *GeoLegend* will delete all the existing data, but will not replace it with new data. This process does not delete the data in the 'Colours' table, which is not geological and so is applicable to any region.

It is possible that you will want to keep the data already entered in the 'Summary rock-type keywords' and 'Time scale' tables because these data may be valid for your region too. In this case, you should delete data from

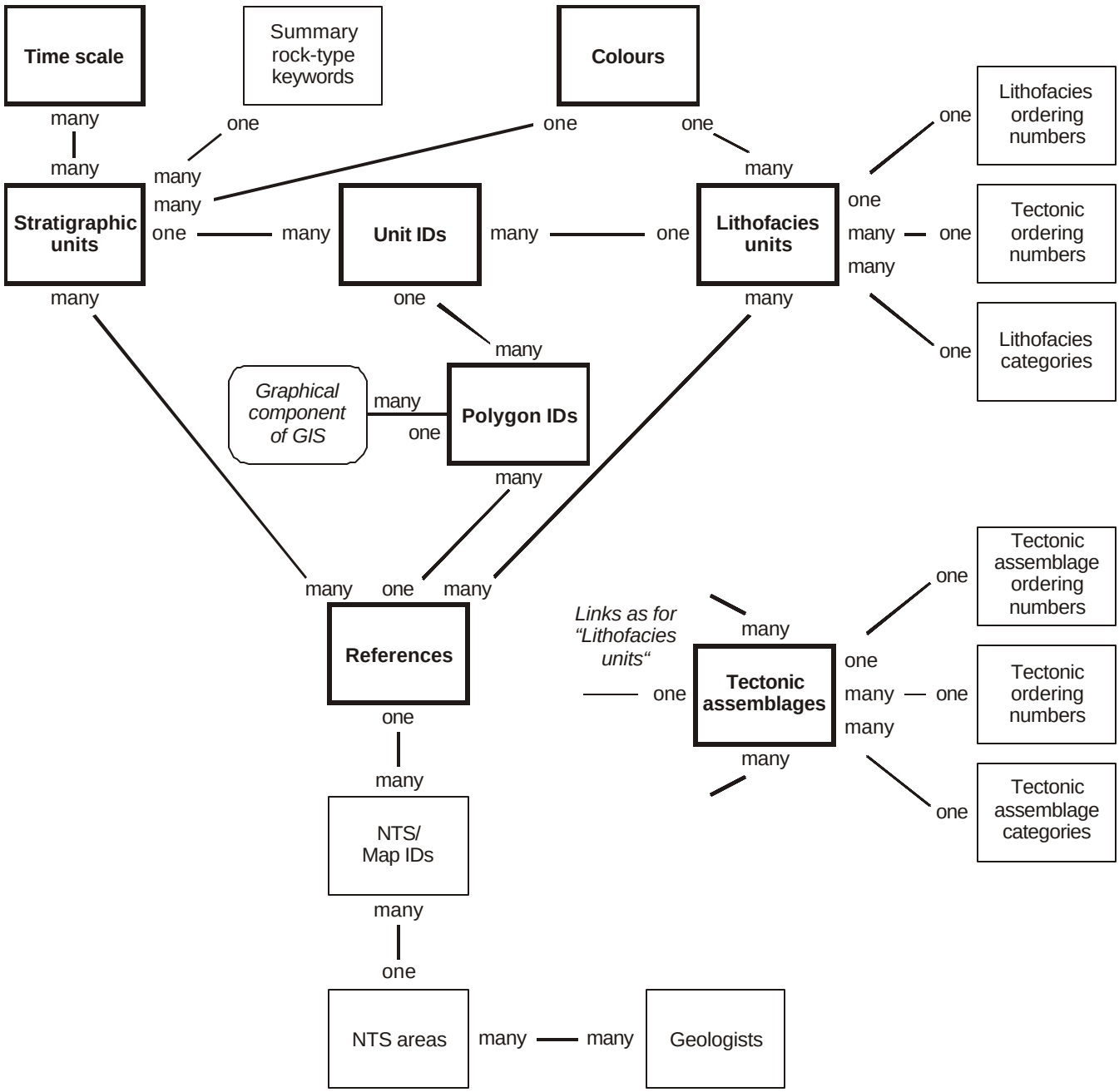

Figure 2. *The* GeoLegend *input tables and the most important relationships between them. The principal input tables are shown in bold type and subsidiary tables in plain type.*

the other tables individually. To delete the old data from the 'Polygon IDs' table (*see* Figure 3), first open the table by selecting it from the 'Table' menu. Then click 'Select records' and click 'Clear' on the 'Polygon IDs: Selection' form; close the selection form. Click on the 'List records' button on the entry form and select 'Delete All' from the 'View' menu.

Follow similar procedures to clear the contents of the 'Unit IDs' and 'Stratigraphic units' tables (*see* Figures 5 and 7).

For the 'Lithofacies units' and 'Tectonic assemblages' tables (*see* Figure 6), clear the selection form, then click on the 'List lithofacies (tectonic assemblage) legend' button and select 'Delete All'. Then click the button 'Ordering numbers for complete lithofacies (tectonic assemblage) legend'. When the new form opens, use the 'List records' button and 'Delete All' command to delete the existing records. Repeat this procedure for the 'Ordering numbers for tectonic divisions…' button.

For the 'References' table (*see* Figure 9), clear the selection form, click the 'List standard references' button, and choose 'Delete All'. Then click the button to open the 'NTS/Map IDs' table. Click the button 'Open NTS/Map IDs list' and choose 'Delete All'. Return to the 'References: Entry form' and click the button to open the 'NTS areas' table. Click the 'List records' button and choose 'Delete All'. Then click the 'List' button under 'Geologist contact info.' and choose 'Delete All'.

Recommended Sequence for Entering Data

Certain tables contain data that are standard for an entire region and which provide values for the pop-up menus on the other tables. It is best to enter as full a set of data as possible into these tables before entering data for individual maps. Additional data can easily be added later, as needed. The sections in this manual for each table contain 'stand-alone' instructions so the user can jump from section to section. The suggested sequence is as follows:

1. Enter data into the 'Time scale' table (*see* Figure 8).

2. (a) Enter data into the 'References' table for all maps that you know you will be processing (*see* Figure 9). If you intend to enter data into the 'Lithofacies units' and/or 'Tectonic assemblage' tables, make sure that the references for the underlying regional source maps are entered into the 'References' table first.

   (b) If you want to be able to sort your references by NTS area, enter all the NTS areas in your region into the 'NTS areas' table, which is accessed through the command button on the 'References: Entry form'. Then link NTS areas to map references in the 'NTS/Map IDs' table, which is also accessed through the 'References: Entry form'.

   (c) If you want to assign individual geologists as experts on particular NTS areas, fill the appropriate fields in the 'NTS areas' table and enter contact information on the entry form for 'Geologist contact

info.' The geologist data is only useful if you intend to use *GeoLegend* to set up a 'Web Map Index'.

3. (a) If you want to be able produce lithofacies maps, open the 'Lithofacies units: Entry form' and click the button, 'Reorder or edit lithofacies categories' (*see* Figure 6). Enter the legend hierarchy to be used for lithofacies maps and post this to the 'Lithofacies units: Entry form' by clicking the 'Enter categories…' command button.

   (b) Enter lithofacies legend data on the 'Lithofacies units: Entry form'.

   (c) Click the command button, 'Ordering numbers for complete lithofacies legend' and enter ordering numbers for the legend.

   (d) Click the command button, 'Ordering numbers for tectonic divisions/subdivisions' and enter ordering numbers for these divisions.

4. (a) If you want to be able produce tectonic assemblage maps, open the 'Tectonic assemblage: Entry form' and click the button, 'Reorder or edit tectonic assemblage categories' (*see* Figure 6; the 'Tectonic assemblages' table uses an identical format to the 'Lithofacies units' table). Enter the legend hierarchy to be used for tectonic assemblages and post this to the 'Tectonic assemblages: Entry form' by clicking the 'Enter categories…' command button.

   (b) Enter tectonic assemblage legend data on the 'Tectonic assemblages: Entry form'.

   (c) Click the command button, 'Ordering numbers for complete tectonic assemblage legend' and enter ordering numbers for the legend.

   (d) Click the command button, 'Ordering numbers for tectonic divisions/subdivisions' and enter ordering numbers for these divisions.

5. If you want to be able to use rock-type criteria for searching a map, enter rock-type keywords into the 'Summary rock-type keywords' table, which is accessed through the entry forms for the 'Lithofacies units', 'Tectonic assemblages' and 'Stratigraphic units' tables (*see* Figures 6 and 7).

6. Enter data for individual maps into the 'Polygon IDs', 'Unit IDs' and 'Stratigraphic units' tables, preferably in sequence (*see* Figures 3, 5 and 7). Add entries to the other tables as required.

GRAPHICAL COMPONENT OF THE GIS

Polygon Identifiers

All polygons, lines and points that represent map units must be assigned unique identifiers.

Each identifier must contain a single underscore character, which separates an alphanumeric string, identifying the source map, from a numeric string identifying the polygon within that map, e.g., NF213_0004 for the fourth polygon in map NF213.

The portion of the identifier in front of the underscore (NF213) can be of any length and can contain any characters, provided that the last three characters are numbers. These three numbers should be sufficient to identify the map in the region. The characters before these can be used to distinguish one region from another. This portion of the identifier must be entered into the field 'GIS ID' in the 'References' table, where it is converted into the more widely used and meaningful GEOSCAN number for the map, entered into the 'Map ID' field. These fields allow recovery of bibliographic information about the source map. 'GIS ID' is used in the graphical component of the GIS because the GEOSCAN number is too long for some GIS to use as a polygon attribute.

The portion of the identifier after the underscore must be an integer having a range from 0001 to 9999. It is convenient to number polygon units from 0001 to 1999, line units from 2000 to 2999, and point units from 3000 upward. Leading zeros are required to make the number four characters in length. The polygon portion of the identifier links with the field 'Polygon ID' in the 'Polygon IDs' table.

Faults

Faults should not be used to define polygon boundaries. All faults should be placed on a separate layer that is stamped onto the map after units have been labelled and generalized to the required level of detail. Where faults form the boundary between two units, the unit boundary should be represented on the polygon layer by some kind of dummy line. This dummy line can then be deleted, if the units on each side are to be shown undivided, without losing the fault.

Dykes and Veins

Dykes and veins are often treated as symbols on geological maps. However, because they can be given lithological descriptions, they should more correctly be considered as units. In most cases they will appear as line units, and they should be given identifiers and treated like any other unit.

POLYGON IDs

Figure 3 shows the entry form for information describing individual map polygons. Although data can be typed directly into the fields, the normal method of entry is to import a text file that has been compiled in a word processor or spreadsheet using data exported from the digitized map.

Entry Variables

Map ID:

The catalogue number assigned to an individual geological source map.

Alphanumeric.

The field must be filled.

If there is a bibliographic catalogue system for geological maps already in place in your region, the numbers in this system would probably be the best ones to use for 'Map ID'. In Canada, the GEOSCAN system fills this role and is recommended.

If the chosen system does not have a number assigned to a particular map, some kind of temporary number will need to be assigned; placing the temporary number in round brackets will cause bibliographic listings produced from the 'References' table to show the catalogue number as "not assigned".

If the catalogue system has a single number assigned to a series of maps, each map should be identified separately by adding a suffix, e.g., "NFLD/0979a", "NFLD/0979b", etc. If a map occurs in a book, add the page number as a suffix, e.g., "NFLD/2345_116".

'Map ID' is also present as a variable in the 'Unit IDs' and 'References' tables. It links the 'Polygon IDs' table to the 'References' table in a many-to-one relationship.

Note that 'Map ID' is not normally the same as 'GIS ID', which is the map number in the polygon identifier in the graphical component of the GIS. There is, however, a one-to-one relationship between the two numbers and one is converted into the other in the 'References' table.

Polygon ID:

The number assigned to a polygon within a geological map.

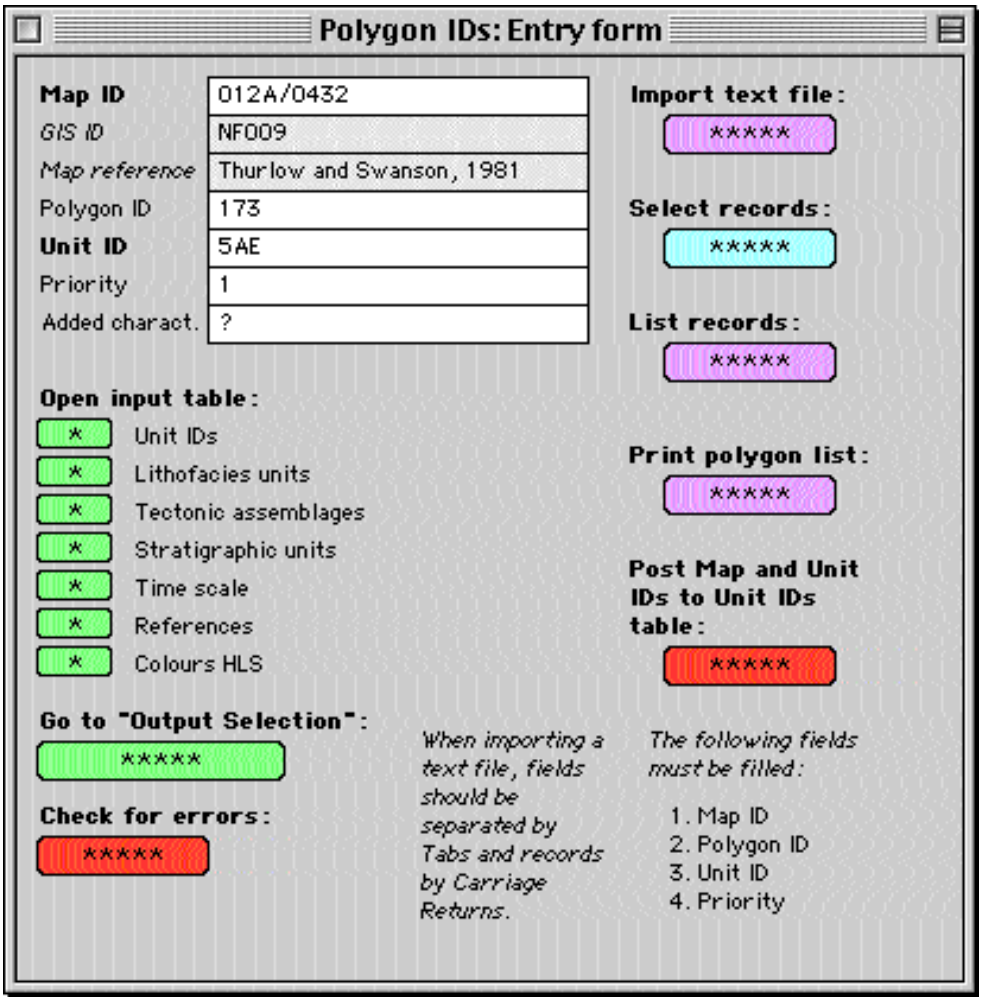

Figure 3. *'Polygon IDs' table. Form used for entering polygon data. Labels in Roman type indicate variables entered directly into the table; bold Roman type is used for variables that are posted to other tables. Labels in italics indicate variables derived from another table; plain italics are used for calculated variables and bold italics for variables that have been posted. Variables for all tables are described in the text.*

Figure 3 is best □ viewed at 112% □ magnification

Numeric, integer. Greater than 0 and less than 10,000.

The field must be filled.

Each polygon, but not each record, is identified uniquely by a combination of 'Map ID' and 'Polygon ID'. The number in 'Polygon ID' should be the same as the number after the underscore in the polygon identifier, for corresponding polygons.

It is suggested that, for each map, true polygons be numbered sequentially from 1 to 1999; lines representing units from 2000 to 2999; and points representing units from 3000 upward.

Unit ID:

The unit label that was applied to a polygon on the original source map.

Alphanumeric.

The field must be filled.

Each map unit is identified uniquely by a combination of 'Map ID' and 'Unit ID'.

Complex labels, showing more than one unit within a polygon, should be separated into their components; *see* 'Priority', below.

Characters added to the unit label for certain polygons should not be included in 'Unit ID'; *see* 'Added characters', below.

On some source maps, unrelated geological entities may be lumped into single units, particularly in marginal areas where the map maker had limited interest. It is usually desirable to "unlump" these units and the following procedures are suggested:

1. If the unrelated entities are always in separate polygons, add a distinguishing number to 'Unit ID' in the different polygons. It is suggested that this be a number in {curly brackets} for easy identification; e.g., if Unit 8 consists of unrelated metamorphic and sedimentary rocks, it can be divided into some polygons that are Unit 8{1} and contain the metamorphic rocks, and others that are Unit 8{2} and contain the sedimentary rocks. This method can also be used to give extra unit definition to related units that were lumped on the original map; e.g., if Unit 10 on a source map is the undivided North Bay Intrusive Suite, it may be possible to divide it into its component intrusions, 10{1} for the Meelpaeg Granite and 10{2} for the Island Pond Granite.

2. If unrelated entities occur in the same polygon, add postscripts to 'Unit ID' as above and produce a complex label for the polygon, e.g., 8{1}/8{2}. The complex label then has to be separated into its components for use in the database, as described below under 'Priority'.

Priority:

A number indicating the order of priority of a unit within a polygon.

Numeric, integer. Greater than 0 and less than 9.

The field must be filled.

Each record in the 'Polygon IDs' table is identified uniquely by a combination of 'Map ID', 'Unit ID' and 'Priority'.

If a polygon has a simple unit label, e.g., "Ssa", one record is created for that polygon and the value of 'Priority' is "1" (Figure 4, Polygon 16). If it has a complex label indicating two unseparated units, e.g., "Ssa/Ssb", two records are created with the same polygon number (Figure 4, Polygon 17). In the first record, 'Unit ID' is "Ssa" and 'Priority' is "1", and in the second, 'Unit ID' is "Ssb" and 'Priority' is "2". A third label would have a 'Priority' of

Figure 4 is best viewed at 157% magnification

Polygon IDs: List records

To export or delete records currently selected by 'Select records', use the 'Export...' or 'Delete...' commands from the 'File' and 'View' menus.

Map ID	GIS ID	Map reference	Poly ID	Unit ID	Priority	Added Char.
NFLD/0979h	NF005	Dean, 1977h	1	OSRa	1	
NFLD/0979h	NF005	Dean, 1977h	2	Sb	1	
NFLD/0979h	NF005	Dean, 1977h	3	Ssa	1	
NFLD/0979h	NF005	Dean, 1977h	4	OSs	1	
NFLD/0979h	NF005	Dean, 1977h	5	Sb	1	
NFLD/0979h	NF005	Dean, 1977h	6	Ssa	1	
NFLD/0979h	NF005	Dean, 1977h	7	OSRp	1	
NFLD/0979h	NF005	Dean, 1977h	8	OSRp	1	
NFLD/0979h	NF005	Dean, 1977h	9	Db2	1	
NFLD/0979h	NF005	Dean, 1977h	10	Sb	1	
NFLD/0979h	NF005	Dean, 1977h	11	OSRa	1	
NFLD/0979h	NF005	Dean, 1977h	12	OSRp	1	
NFLD/0979h	NF005	Dean, 1977h	13	DgT	1	
NFLD/0979h	NF005	Dean, 1977h	14	Db3	1	
NFLD/0979h	NF005	Dean, 1977h	15	Ssb	1	
NFLD/0979h	NF005	Dean, 1977h	16	Ssa	1	
NFLD/0979h	NF005	Dean, 1977h	17	Ssa	1	
NFLD/0979h	NF005	Dean, 1977h	17	Ssb	2	
NFLD/0979h	NF005	Dean, 1977h	18	Ssb	1	
NFLD/0979h	NF005	Dean, 1977h	19	Dg	1	
NFLD/0979h	NF005	Dean, 1977h	20	OB?	1	
NFLD/0979h	NF005	Dean, 1977h	21	Sm	1	
NFLD/0979h	NF005	Dean, 1977h	22	C	1	?
NFLD/0979h	NF005	Dean, 1977h	23	Dp	1	
NFLD/0979h	NF005	Dean, 1977h	24	OB	1	
NFLD/0979h	NF005	Dean, 1977h	25	DgT	1	
NFLD/0979h	NF005	Dean, 1977h	26	lOc	1	
NFLD/0979h	NF005	Dean, 1977h	27	lOc	1	
NFLD/0979h	NF005	Dean, 1977h	28	lOc	1	
NFLD/0979h	NF005	Dean, 1977h	29	lOc	1	

Figure 4. *List showing a selection of records from the 'Polygon IDs' table. Note the two records for polygon 17 that have different priority values; these allow a compound label to be built for the polygon (e.g., 'Ssa/Ssb'). The question marks in the 'Added characters' field indicate polygons where the geologist was uncertain about the assigned unit and added a question mark to the original label.*

"3", and so on. The unit that has a 'Priority' of "1" is the dominant unit and is used to control the colour of the polygon on the final map, but all units in the polygon are represented in the label and all units appear on the legend.

Added characters:

Character(s) added to the unit label on the source map for certain polygons.

Alphanumeric.

The field may be left empty.

In some polygons, characters may be attached to the unit label without being part of it. For example, a geologist may have been uncertain about assigning a polygon to a particular unit and added a question mark to the label, e.g., "C?" (Figure 4, polygon 22). The question mark should be placed in the 'Added characters' field and omitted from the entry in 'Unit ID'. It will then be added to the label when a map is created, but it will not generate a separate unit, "C?", on the legend. A distinction must be made between polygons of uncertain assignment and units of uncertain assignment. If the polygon is of uncertain assignment, the original map legend will have one entry for the unit ("C" in the example above) and the question mark is placed in the 'Added characters' field. If the unit is of uncertain assignment, there will be two entries in the legend, one for unit "C" and one for unit "C?". In this case, the question mark should be treated as part of the unit designation and included in the 'Unit ID' field; the 'Added characters' field should be left blank (e.g., in Figure 4, "OB?" in polygon 20 is a distinct unit from "OB" in polygon 24).

Other examples of added characters are suffixes indicating grade of metamorphism or alteration. In many cases, it is a matter of choice as to whether these suffixes should be treated as separate from the unit label or whether they should be used to indicate a series of distinguishable units. Each case should be judged on its own merits, but once a decision has been made, it must be applied consistently.

Computed Variables

GIS ID:

The identifying number in the graphical component of the GIS for the map entered in 'Map ID'. It is the first part of the polygon identifier and is derived from the 'References' table.

Map reference:

The short-form reference for the map in 'Map ID'. It is derived from the 'References' table.

Command Buttons

Open input table:

Clicking on one of these buttons opens the entry form for that table.

Go to "Output Selection":

Opens a form containing all the command buttons and menus required to generate polygon labels, legend, and data and reference lists for a given area.

Check for errors:

Checks the entire contents of the 'Polygon IDs' table for records that have duplicate combinations of 'Map ID', 'Unit ID' and 'Priority'. Only one of a duplicate pair is shown and this is not necessarily the one containing the mistake. The check also scans for fields that should be filled but are not.

Import text file:

Opens a dialogue box so that the user can select a text file to import into the 'Polygon IDs' table; when the selection has been made, a button in the box allows the file to be imported. The text file must contain a field for each of the five entry variables on the form; each field, except 'Added characters', must be filled on every record. The default setting is for fields to be separated by tabs, and records by carriage returns. This setting can be changed by clicking the 'Options' button in the dialogue box. Note that no special distinction should be made between alphanumeric and numeric strings in the text file; do NOT enclose alphanumeric strings in quotes.

Select records:

Opens a dialogue box so that the user can select records with particular values of the variables in the 'Polygon IDs' table.

List records:

Opens a window showing a list of records that meet the criteria defined in the 'Select records' dialogue box.

Double-clicking on a record opens the entry form with that record showing; it can then be edited.

Records can be exported to a text file by choosing 'Export All' from the 'File' menu, or by selecting records from the list and choosing 'Export Selections'.

Records can be deleted by choosing 'Delete All' from the 'View' menu, or by selecting records from the list and choosing 'Delete Selections'.

Print polygon list:

Prints a list of records in the 'Polygon IDs' table that meet the criteria defined in the 'Select records' dialogue box. Figure 4 shows a typical listing.

Post Map and Unit IDs to Unit IDs table:

Creates a new record in the 'Unit IDs' table for every combination of 'Map ID' and 'Unit ID' in the 'Polygon IDs' table that is not already present in the 'Unit IDs' table. It then enters the appropriate values of 'Map ID' and 'Unit ID'. These two variables are the keys that link the 'Polygon IDs' and 'Unit IDs' tables.

Only those records meeting the criteria defined in the 'Select records' dialogue box are considered for posting.

Preparing a Text File

The following procedure is suggested as an efficient way to enter data into the 'Polygon IDs' table:

1. In the graphical component of the GIS, attribute each polygon with its polygon identifier and original unit label; modify the original label with a distinguishing number if necessary (*see* "Unit ID", above).

2. Download a list of identifiers and unit labels and import the list into a word processor (alternatively the editing can be done in a spreadsheet). For three polygons, the initial list might look like this:

```
NF231_0023:8¶
¬NF231_0024:4,9¶
¬NF231_0025:6?¶
¶
```

3. Globally replace the character separating the identifier from the unit label (:) with a tab (>).

```
NF231_0023>8¶
¬NF231_0024>4,9¶
¬NF231_0025>6?¶
¶
```

4. Globally replace the part of the identifier indicating the map and the underscore character that follows it with the proper map catalogue number (GEOSCAN number in Canada), followed by a tab.

```
001M/12/0177>0023>8¶
¬001M/12/0177>0024>4,9¶
¬001M/12/0177>0025>6?¶
¶
```

5. Globally replace the carriage return at the end of each record using the sequence 'tab 1 tab carriage return'. The number 1 is the default value in the 'Priority' field.

```
001M/12/0177>0023>8>1>¶
¬001M/12/0177>0024>4,9>1>¶
¬001M/12/0177>0025>6?>1>¶
>1>¶
```

6. Scan the list for unwanted characters such as redundant line feeds (¬) or surplus carriage returns at the beginning or end of the file. Remove these, using global changes where possible.

```
001M/12/0177>0023>8>1>¶
001M/12/0177>0024>4,9>1>¶
001M/12/0177>0025>6?>1>¶
```

7. Scan the column containing the unit labels for complex labels and added characters:

   (a) If a complex label is found, copy the record as many times as there are separate units in the complex label. Place one unit label only in each copy of the record. Then change the number in the 'Priority' column so that the records are numbered 1, 2, etc.

```
001M/12/0177>0023>8>1>¶
001M/12/0177>0024>4>1>¶
001M/12/0177>0024>9>2>¶
001M/12/0177>0025>6?>1>¶
```

(b) If an added character is found, delete it from the unit label and insert it in the 'Added characters' field just before the carriage return.

001M/12/0177>0023>8>1>¶
001M/12/0177>0024>4>1>¶
001M/12/0177>0024>9>2>¶
001M/12/0177>0025>6>1>?¶

8. Open *GeoLegend* and import the file into the 'Polygon IDs' table using the 'Import text file' button.

Processing Polygon IDs

After the file has been imported into the 'Polygon IDs' table, it should be checked for errors by clicking the 'Check for errors' button. A list form opens showing one of a pair of duplicate records, if these exist, or records with fields that need to be filled. Double click on a record to show it on the entry form and check it relative to the ones before and after. Correct the error.

If no records are shown on the list form, the data in the table are ready for posting to the 'Unit IDs' table. Click the button to 'Post Map and Unit IDs to Unit IDs table'. You can speed up the posting process by selecting only those records that have just been imported into the 'Polygon IDs' table, using the 'Select records' button.

You are now ready to start entering data into the 'Unit IDs' table.

Replacing Polygon IDs

It is common for the polygon numbers in an entire map sheet to be changed and to need replacing in the 'Polygon IDs' table. This may happen, for instance, if a new polygon is added to a map in the graphical component of the GIS, and the GIS renumbers the polygons to accommodate it. In most cases only the 'Polygon IDs' table will require revision, which is best done as follows:

1. Prepare a new text file from the polygon identifiers and unit labels, as described above in ''Preparing a text file''.

2. Open the 'Polygon IDs' table and click the 'Select records' button. In the dialogue box, select the records to be replaced by specifying the appropriate 'Map ID'.

3. Click the 'List records' button and the list should show only the records from the selected map. Choose 'Delete All' from the 'View' menu.

4. Import the new text file for the map by clicking the 'Import text file' button.

5. Click 'Check for errors' to make sure there are no errors in the file.

6. Click 'Post Map and Unit IDs to Unit IDs table'. If this posting was done for the previous set of polygon numbers, only extra 'Unit IDs' that were added to the file since then will be added to the 'Unit IDs' table.

7. In the 'Unit IDs' table, check for any added units by selecting the 'Map ID' and listing the records. New units will lack values in their lithofacies, tectonic assemblage and unit name fields, and these will have to be filled out as described under "Unit IDs", below.

8. In the 'Unit IDs' table, click the button 'Check for orphaned records'. In the case that some units in the old list of polygon numbers do not occur in the new list, this button will identify all 'Map ID' and 'Unit ID' combinations that occur in the 'Unit IDs' table but no longer have corresponding records in the 'Polygon IDs' table. They can be deleted from the 'Unit IDs' table. A similar utility is available in the 'Stratigraphic units' table for checking for records in that table that do not have corresponding records in the 'Unit IDs' table.

9. A field, 'Polygon IDs last updated', in the 'References' table, automatically records when the last update was done for a particular map.

UNIT IDs

Figure 5 shows the entry form for reclassifying units on each map sheet, using lithofacies units, tectonic assemblages, and the hierarchical scheme based on the stratigraphic code (variables 'Supergroup' to 'Sub4-unit').

Entry Variables

Map ID:

The catalogue number assigned to an individual geological source map.

Alphanumeric.

Figure 5 is best viewed at 159% magnification

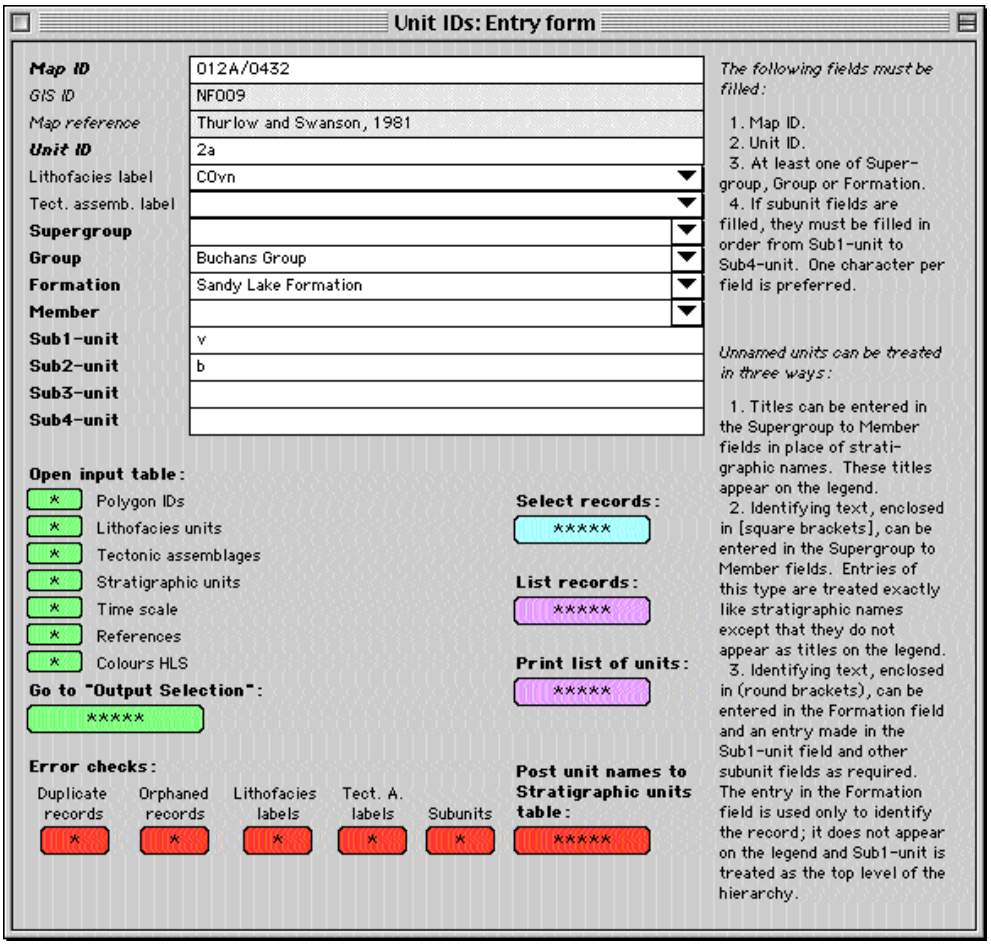

Figure 5. *'Unit IDs' table. Form used to classify units, according to lithofacies and tectonic assemblage legend schemes and the stratigraphic code. Clicking on the downward-facing triangles produces pop-up menus from which values can be selected. If the triangle is enclosed, values can be typed in as well as being taken off the menu.*

The field must be filled.

This variable corresponds to 'Map ID' in the 'Polygon IDs' table and is entered automatically when the 'Post...' button is clicked on that table's entry form. More information is given in the description of "Entry Variables" under "Polygon IDs".

'Map ID' links the 'Unit IDs' table to the 'References' table in a many-to-one relationship.

Unit ID:

The unit label that was applied to a polygon on the original source map.

Alphanumeric.

The field must be filled.

This variable corresponds to 'Unit ID' in the 'Polygon IDs' table and is entered automatically when the 'Post...' button is clicked on that table's entry form. More information is given in the description of "Entry Variables" under "Polygon IDs".

Each record in the 'Unit IDs' table is identified uniquely by a combination of 'Map ID' and 'Unit ID' and this combination links the 'Unit IDs' and 'Polygon IDs' tables in a one-to-many relationship.

Lithofacies label:

The label to be used for the unit if a map is constructed using a lithofacies classification for the region.

Alphanumeric.

The field may be left empty.

Values can only be entered from the pop-up menu, which lists all values currently entered into the 'Lithofacies label' field in the 'Lithofacies units' table. The 'Lithofacies units' table should therefore be filled out before data are entered into the 'Unit IDs' table.

Lithofacies maps are usually published at very small scales. Although most units on more detailed maps can be matched to lithofacies units, there may be some units that always occur in outcrop areas too small to show at the scale of the published lithofacies map, and which do not fall within any

of the units described on the lithofacies legend. In these cases, extra lithofacies units should be created and entered into the 'Lithofacies units' table so that the lithofacies classification can be used at large scales as well as small.

'Lithofacies label' links the 'Unit IDs' and 'Lithofacies units' tables in a many-to-one relationship.

Tectonic assemblage label:

The label to be used for the unit if a map is constructed using a tectonic assemblage classification for the region.

Alphanumeric.

The field may be left empty.

Values can only be entered from the pop-up menu, which lists all values currently entered into the 'Tectonic assemblage label' field in the 'Tectonic assemblages' table. The 'Tectonic assemblages' table should therefore be filled out before data are entered into the 'Unit IDs' table.

Tectonic assemblage maps are usually published at very small scales. Although most units on more detailed maps can be matched to tectonic assemblages, there may be some units that always occur in outcrop areas too small to show at the scale of the published tectonic assemblage map, and which do not fall within any of the units described on the tectonic assemblage legend. In these cases, extra assemblages should be created and entered into the 'Tectonic assemblages' table so that the tectonic assemblage classification can be used at large scales as well as small.

'Tectonic assemblage label' links the 'Unit IDs' and 'Tectonic assemblages' tables in a many-to-one relationship.

Supergroup:

Name of the supergroup (or lithodemic equivalent) to which the unit belongs, if any.

Alphanumeric.

The field may be left empty (*see* "Note on unnamed units", below).

Values can be typed in, but when a value is present on one record, it appears on the pop-up menu and should thereafter be entered by selecting it from the menu.

Group:

Name of the group (or lithodemic equivalent) to which the unit belongs, if any.

Alphanumeric.

The field may be left empty (*see* "Note on unnamed units", below).

Values can be typed in, but when a value is present on one record, it appears on the pop-up menu and should thereafter be entered by selecting it from the menu.

Formation:

Name of the formation (or lithodemic equivalent) to which the unit belongs, if any.

Alphanumeric.

The field may be left empty (*see* "Note on unnamed units", below).

Values can be typed in, but when a value is present on one record, it appears on the pop-up menu and should thereafter be entered by selecting it from the menu.

Note on unnamed units:

At least one of fields, 'Supergroup', 'Group' or 'Formation', must be filled, even though the map unit may be unnamed. Unnamed units are treated in three ways, depending on the form of the entry in these fields:

1. If an entry is not enclosed in brackets, it is simply treated like a stratigraphic name. An example might be "Unnamed ophiolitic rocks", which could be placed in the 'Supergroup' field for any small occurrence of ophiolite that does not belong to a named complex. Entries of this type can be placed in any or all of the three fields.

2. If an entry is enclosed in [square brackets], it is treated exactly like a stratigraphic name except that it does not appear as a title on legends. Entries of this type can be placed in any or all of the three fields.

3. If an entry is enclosed in (round brackets), it should be placed in the 'Formation' field and the other two fields should be left empty. Such an entry is used for identification purposes for records where labels

and legend descriptions are only assigned at the Sub1-unit level and below. Entries in the subunit fields are normally single characters and are insufficient to identify records uniquely. This type of entry differs from entries enclosed in square brackets (2) in that Sub1-unit is treated as the highest level of the hierarchy. This method is preferred for many unnamed units because subunits are not subject to rigid hierarchical sorting on legends and are therefore better suited for simple lithological divisions (*see* "Relative age ordering number" under "Stratigraphic units", below).

Member:

Name of the member (or lithodemic equivalent) to which the unit belongs, if any.

Alphanumeric.

The field may be left empty.

Values can be typed in, but when a value is present on one record, it appears on the pop-up menu and should thereafter be entered by selecting it from the menu.

Sub1-unit:

A character, or characters, to identify the first level below 'Member' for a unit.

Alphanumeric.

The field may be left empty, unless the 'Formation' field is enclosed in round brackets (*see* "Note on unnamed units", above) or a subunit of a lower rank is filled.

Notes on subunits:

You should try to make subunits hierarchical. For instance, if the unit is one of several volcanic subdivisions in a formation, you might place all of these subdivisions in 'Sub1-unit' "v", for volcanic. Then 'Sub2-unit' can be used to distinguish different compositions of volcanic rock, e.g., "b" for basalt, "f" for felsic. If the felsic rocks consist of breccia units and tuff units, these might be distinguished by "x" and "t" in the 'Sub3-unit' field, and the tuff may be divided into crystal, "c", and lithic, "l", in the 'Sub4-unit' field. This would make it possible to produce maps that have all the volcanic rocks lumped together, or the basaltic rocks separated from undivided felsic rocks,

or felsic breccia separated from felsic tuff, or all the units separated as on the source map.

A single letter is preferred as the designation for a subunit and is incorporated into the unit label. More letters can be used if necessary, but care must be taken to avoid two potential problems:

1. The unit label may become unmanageably long and be confusing, as well as cluttering the map.

2. The same unit label may get applied to different units. If we divide a unit at the 'Sub1-unit' level into "c" and "cp", they can be easily distinguished. However, if the "c" unit is then divided at the Sub2-unit level into "p" and "g", we will derive a label string, "cp", which is the same as the label for a different unit at the 'Sub1-unit' level.

Sub2-unit:

A character, or characters, to identify the second level below 'Member' for a unit.

Alphanumeric.

The field may be left empty, unless a subunit of a lower rank is filled.

Sub3-unit:

A character, or characters, to identify the third level below 'Member' for a unit.

Alphanumeric.

The field may be left empty, unless 'Sub4-unit' is filled.

Sub4-unit:

A character, or characters, to identify the fourth level below 'Member' for a unit.

Alphanumeric.

The field may be left empty.

The 'Sub4-unit' level should only be used when absolutely necessary, because it implies a label that is at least five characters long, which is close to the limit of what is easily readable on a map.

Computed Variables

GIS ID:

The identifying number in the graphical component of the GIS for the map entered in 'Map ID'. It is the first part of the polygon identifier and is derived from the 'References' table.

Map reference:

The short-form reference for the map in 'Map ID'. It is derived from the 'References' table.

Command Buttons

Open input table:

Clicking on one of these buttons opens the entry form for that table.

Go to "Output Selection":

Opens a form containing all the command buttons and menus required to generate a map, legend, and data and reference lists for a given area.

Error checks:

All error checks apply to the entire contents of the 'Unit IDs' table, not just the records that meet the 'Select records' criteria.

Duplicate labels:

Checks the entire contents of the 'Unit IDs' table for records that have duplicate combinations of 'Map ID' and 'Unit ID'. Only one of a duplicate pair is shown and this is not necessarily the one containing the mistake.

Orphaned records:

Checks the entire contents of the 'Unit IDs' table for records that have no corresponding combinations of 'Map ID' and 'Unit ID' in the 'Polygon IDs' table. In most cases, this is because the record in the 'Polygon IDs' table has been deleted for some reason. If it was deleted intentionally, then the record in the 'Unit IDs' table can also be deleted.

Lithofacies labels:

Checks that units with the same set of entries in the 'Supergroup' to 'Sub4-unit' fields also have the same entry in the 'Lithofacies label' field.

Note that, although different lithofacies entries usually indicate an error, this is not necessarily the case, especially if the stratigraphic designation is very generalized.

The check also lists any units that have no entry in the 'Lithofacies label' field and any units that have a lithofacies label that is not present in the 'Lithofacies units' table. The latter error can arise if lithofacies labels are changed in the 'Lithofacies units' table and corresponding changes are not made in the 'Unit IDs' table. These two checks are only made if lithofacies categories have been set up. Otherwise, it is assumed that you are not using the lithofacies classification.

Tectonic assemblage labels:

Performs the same error checks for tectonic assemblages as the 'Lithofacies label' button does for lithofacies.

Subunits:

Checks that the subunit fields have been filled in sequence. For example, a record will appear on the list if it has an entry in 'Sub2-unit' but not in 'Sub1-unit'.

Select records:

Opens a dialogue box so that the user can select records having particular values of variables in the 'Unit IDs' table.

List records:

Opens a window showing a list of records that meet the criteria defined in the 'Select records' dialogue box.

Double-clicking on a record opens the entry form with that record showing; it can then be edited.

Records can be exported to a text file by choosing 'Export All' from the 'File' menu, or by selecting records from the list and choosing 'Export Selections'.

Records can be deleted by choosing 'Delete All' from the 'View' menu, or by selecting records from the list and choosing 'Delete Selections'.

Print list of units:

Prints a list of records in the 'Unit IDs' table that meet the criteria defined in the 'Select records' dialogue box.

Post unit names to Stratigraphic units table:

Creates new records in the 'Stratigraphic units' table for each of the stratigraphic units in the 'Unit IDs' table that do not already have a record in that table, and enters the names or letters into the appropriate fields. Only those records meeting the criteria defined in the 'Select records' dialogue box are considered for posting.

Posting of unit names is done for each level in the stratigraphic hierarchy, so that a single record in the 'Unit IDs' table, with four stratigraphic levels represented, produces four records in the 'Stratigraphic units' table. For example, this record in the 'Unit IDs' table:

Supergroup	Group	Formation	Member	Sub1-unit	Sub2-unit	Sub3-unit	Sub4-unit
	Buchans Group	Sandy Lake Formation		v	b		

produces the following four records in the 'Stratigraphic units' table:

Supergroup	Group	Formation	Member	Sub1-unit	Sub2-unit	Sub3-unit	Sub4-unit
	Buchans Group						
	Buchans Group	Sandy Lake Formation					
	Buchans Group	Sandy Lake Formation		v			
	Buchans Group	Sandy Lake Formation		v	b		

Computed variables that are derived from the eight stratigraphic variables, from 'Supergroup' to 'Sub4-unit', are the keys that link the 'Unit IDs' and 'Stratigraphic units' tables. In the 'Unit IDs' table, the computed variable first follows instructions from the user as to what level of detail is desired for the unit, and then lists the requested fields in a continuous string. Thus, if the formation level of detail is requested, entries below this level are disregarded and the computed variable in the 'Unit IDs' table for the above example is:

Buchans GroupSandy Lake Formation

The computed variable to which this is matched in the 'Stratigraphic units' table is a continuous string of the entries in all eight unit name fields. In this example, the computed variable in the 'Unit IDs' table will find a match in the second of the four records in the 'Stratigraphic units' table, and *GeoLegend* will use labels, captions, and age information from this record. Records in the 'Unit IDs' table have a many-to-one relationship with records in the 'Stratigraphic units' table.

Processing Unit IDs

After values have been posted for 'Map ID' and 'Unit ID' from the 'Polygon IDs' table, the 'Unit IDs' table contains a series of records in which

these are the only two fields that are filled. For these records, fill in 'Lithofacies label' and 'Tectonic assemblage label', if required, from values on the pop-up menus on the entry form, and fill in the appropriate unit name fields, always using values on the pop-up menus when these are available. Unit names should only need to be typed into one record in *GeoLegend*; after that they will appear on the pop-up menu for the particular field.

When entering new data, it is often convenient to use the 'Select records' button to select only those records that need entries. Usually this is best done by selecting a particular 'Map ID'. Alternatively, if lithofacies labels are being entered, setting "L'facies label undef…" equal to "Ch: undefined" will find all records in which no entry has been placed in this field. A similar method can be used if labels are being entered for tectonic assemblages. As records are completed, they will be removed from the selected list.

After you have entered all the desired information into the lithofacies, tectonic assemblage and unit name fields, the records should be checked for errors by clicking the five buttons for 'Error checks' at the bottom of the entry form. In each case, a list form opens showing records that need to be examined for possible errors.

When all errors have been corrected, the data in the table are ready for posting. Click the button to 'Post unit names to Stratigraphic units table'. You can speed up the posting process by selecting only those records that have just been entered, using the 'Select records' button.

You are now ready to start entering data into the 'Stratigraphic units' table.

Revising 'Map ID' and 'Unit ID'

Revisions are sometimes needed to the entries in the 'Unit ID' and, less commonly, in the 'Map ID' fields. Special care must be taken in making these revisions because the two variables provide the link with the 'Polygon IDs' table. Any changes must be matched by corresponding changes in the 'Polygon IDs' table.

Revisions should be checked for accuracy by:

1. Posting from the 'Polygon IDs' table to the 'Unit IDs' table; unmatched records in the 'Polygon IDs' table will show up as new records in the 'Unit IDs' table.
2. Checking for orphaned records in the 'Unit IDs' table; unmatched records in the 'Unit IDs' table will be listed on the orphaned record list.

LITHOFACIES UNITS

Figure 6 shows the entry form for information needed to plot a map and legend using the lithofacies units for a region. Both the 'Lithofacies units' and 'Tectonic assemblages' tables also provide information on tectonic divisions, when these are requested as sorting criteria on legends using the stratigraphic hierarchy.

The term "lithofacies" is used in a generic sense to include any regional geological classification based loosely on rock type and environment of formation. The 'Tectonic assemblages' table has exactly the same structure as the 'Lithofacies units' table and regional classifications can be entered into either or both. The purpose of having two tables is to allow entry of two parallel classifications. In Newfoundland and Labrador, the 'Lithofacies units' table is used for local classifications, and the 'Tectonic assemblages' table is used for the classification based on the Canadian Cordillera model, which has been proposed as the standard classification by the CGKN for Canada as a whole. The user-defined variables in both tables allow a variety of regional map classifications to be entered, including those used in the Appalachians (e.g., Colman-Sadd *et al.*, 1990), the Canadian Shield (e.g., Wardle *et al.*, 1997), and the Canadian Cordillera (tectonic assemblages) (Gabrielse *et al.*, 1991).

If you do not want to present map information in the lithofacies format, it is not necessary to fill out the 'Lithofacies units' table. Note that in this case, you will not need, or be able, to enter values in the 'Lithofacies label' field of the 'Unit IDs' table. If you do want to use the 'Lithofacies units' table, it should be filled out before data are entered into the 'Unit IDs' table, although additions and changes can be made at any time.

Entry Variables

User defined variables:

These five variables occupy the first five fields on the 'Lithofacies units: Entry form'. Their main purpose is to store the hierarchical legend titles for a lithofacies map. The kind of legend title (category) to be stored by a particular variable is defined by clicking the 'Reorder or edit lithofacies categories' button, and entering the desired categories onto a form. These categories then appear as the field labels on the entry form (e.g., "Tectonic division" for the first field on Figure 6). See instructions for the 'Reorder...' button under "Command buttons", below. Once the categories have been defined, actual values for each category can be entered on the entry form.

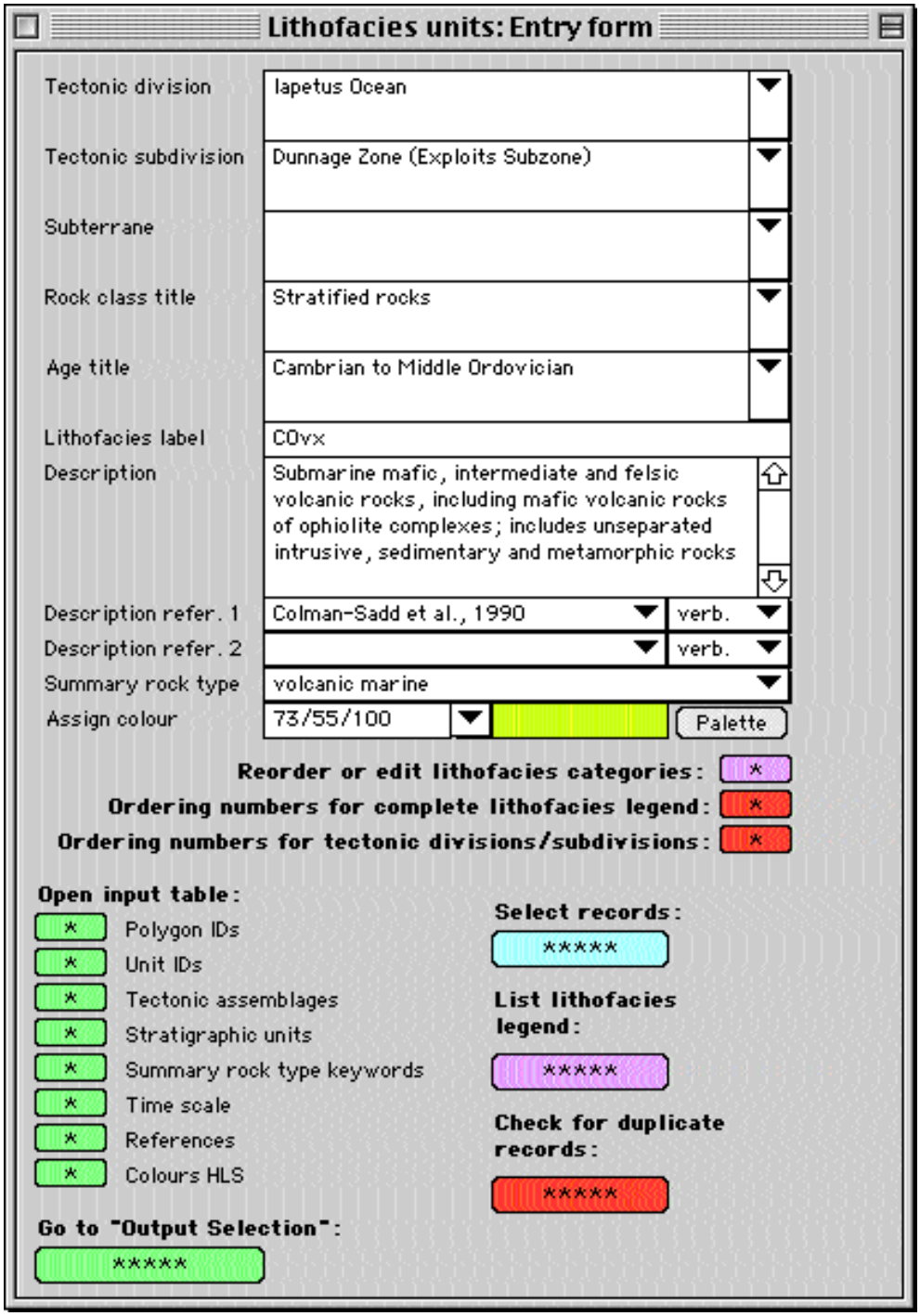

Figure 6. *'Lithofacies units' table. Form used to enter legend information for lithofacies units. A similar form is used for entering data into the 'Tectonic assemblages' table.*

Figure 6 is best viewed at 113% magnification

Alphanumeric.

Individual fields may be left empty.

Values can be typed in, but when a value is present on one record, it appears on the pop-up menu and should thereafter be entered by selecting it from the menu.

Lithofacies label:

The unit label as used on the lithofacies map for the region.

Alphanumeric.

The field must be filled, if the 'Lithofacies units' table is being used.

Each record in the 'Lithofacies units' table is identified uniquely by its 'Lithofacies label' and this field is the key that links the 'Lithofacies units' and 'Unit IDs' tables in a one-to-many relationship.

It is not necessary to adhere rigidly to the legend accompanying the lithofacies map for a region. Developments since the publication of the map may require that some units be amalgamated, split or otherwise changed. Also rock units are commonly shown on detailed maps that have no corresponding units on the printed lithofacies map. This is usually because their outcrop areas are always too small to show at the scale of the lithofacies map. New lithofacies units will need to be created for these.

Description:

Description of the unit to be printed on a lithofacies legend.

Alphanumeric.

The field must be filled.

Description reference 1:

A short-form reference for the description of the unit.

Alphanumeric.

The field must be filled and the record cannot be entered unless it is.

Values can only be entered off the pop-up menu. This menu contains all references currently entered into the 'References' table and, if the appropriate reference is not on the menu, it must be entered into the 'References' table first.

Up to two references can be entered for a record. If there are more than two references for the description, enter "various sources".

The field can be flagged as either "verb.", for verbatim, or "comp.", for compiled. Except when "various sources" is chosen "verb." is the default value and the short-form reference will be printed at the end of the legend description without any prefix; "verb." indicates that the description is copied unchanged from the source document. If the description is significantly changed from the source document, "comp." should be chosen and this will prefix the reference, e.g., "(comp. Bostock *et al*., 1983b)".

The references on a lithofacies legend are usually the same for all descriptions because in most cases they all refer to the same published lithofacies map for the region. If the legend is printed using a command button on the 'Output Selection' form, the references are included at the ends of descriptions but can be easily removed by a global change in a word processor. When a lithofacies legend is exported directly from the 'Lithofacies units' table, using the 'List lithofacies legend' command button, the references are omitted.

Description reference 2:

A short-form reference for the description of the unit.

Alphanumeric.

The field may be left empty; it can only be filled if 'Description reference 1' is filled first.

Entry and flagging is the same as for 'Description reference 1', above.

Summary rock type:

A keyword summary description of the lithology of a unit.

Alphanumeric.

The field may be left empty.

Values can only be entered off the pop-up menu. This menu contains keywords that have been entered into the 'Summary rock-type keywords' table, which is accessed by a command button at the bottom of the 'Lithofacies units: Entry form'. The same keyword list is used by an analogous field in the 'Stratigraphic units' table.

Keywords are best set up in a hierarchical fashion (e.g., "volcanic mafic marine") so that they can be searched at different levels of the hierarchy. The 'Summary rock-type keywords' table allows for an initial division of units by rock class, e.g., "igneous", "metamorphic" or "sedimentary".

For many lithofacies units, a keyword is an oversimplification of the various rock types that may exist in the unit; a keyword that most closely represents the characteristic rocks within the unit should be chosen.

Assign colour:

The colour to be used for the unit on plotted maps, expressed numerically using the HLS colour system (hue, lightness, saturation).

Alphanumeric.

The field may be left empty.

Values can be typed in but this is not the preferred entry method. In most cases, the colours used on the lithofacies map should first be entered in the 'Colours' table (*see* "Colours", below, for how to do this). If this has been done, click on the 'Palette' command button. Find the required colour on the 'Colour palette' and double click on it. This opens a window called 'Colour value'. Select and copy the HLS value in this window and paste it into the 'Assign colour' field. Note that various sort orders are available for the 'Colour palette' under the 'Set' menu.

Colours that have been entered in the 'Lithofacies units' table appear on the pop-up menu in the 'Assign colour' field on both the 'Lithofacies units' and 'Stratigraphic units' entry forms. A menu item shows a lithofacies label and the corresponding HLS value, but only enters the HLS value in the field. In a few cases, colours are repeated on a lithofacies map and the repeated entries can be taken from the menu. The menu feature, however, is mainly intended for the 'Stratigraphic units' table, where the lithofacies colours can often be used as a guide for colouring the main stratigraphic hierarchies.

The computed field next to the 'Assign colour' field shows an image of the colour, looked up from the 'Colours' table.

Command Buttons

Palette:

Click the button to open the 'Colour palette' (*see* 'Assign colour', above).

Reorder or edit lithofacies categories:

Click the button to open a form on which the various legend categories can be entered.

The main division of the legend should be entered in Level 1, sub-divisions of the main division in Level 2, and so on. It is not necessary to fill out all the levels.

Entries can either be typed in or they can be taken off the pop-up menu. The pop-up menu contains entries that are recognized by *GeoLegend* as keywords and so these should be used if they apply. For instance, if "Tectonic division" is entered rather than, say, "Structural province" or "Tectono-stratigraphic zone", *GeoLegend* will be able to sort stratigraphic as well as lithofacies legends using this category, if it is instructed to produce a tectonic legend in 'Output Selection'.

Similarly, if "Age title" or "Rock class title" are used for variables, *GeoLegend* can place the contents of these fields in the correct headers in a legend that mixes lithofacies and stratigraphic units. Note that "Rock class title" does not have to adhere to the strict petrologic rock class division of "igneous", "sedimentary" and "metamorphic", but can use some variation of the looser morphological classification common on legends (e.g., "stratified", "intrusive" etc.).

Entries can be flagged for use in sorting lithofacies legends by checking the box next to the entry field. In most cases, all categories will be checked, but there are some circumstances where it is useful to fill out a field but leave it unchecked. For example, you may wish to use a much broader grouping of tectonic divisions on lithofacies legends than you do for stratigraphic legends. You can achieve this by filling one field with a non-keyword entry like "Tectonic title" and checking the box; this category will be used to provide the tectonic sorting on lithofacies legends. Two other fields can then be designated with the keywords "Tectonic division" and "Tectonic subdivision" and their boxes left unchecked; these categories will be used to sort stratigraphic legends when the tectonic option is chosen, but will not affect the sorting of lithofacies legends.

When the categories have been filled in, they can be entered by clicking on the button 'Enter categories on Lithofacies units entry form'.

Ordering numbers for complete lithofacies legend:

The sorting of the lithofacies legend is achieved by sets of ordering numbers for each category that was checked on the category form (*see* "Reorder or edit lithofacies categories"). These numbers should be filled in after all the units have been entered into the 'Lithofacies units: Entry form'.

Clicking on the button begins by making entries in the ordering number table for all the units in the 'Lithofacies units' table. It then opens the form for the top level category, 'Ordering Level 1'.

The 'Ordering Level 1' form shows a list of all the entries in the top level category in the 'Lithofacies units' table. Double clicking on any of these brings them into the edit field where the ordering number for the entry can be assigned or edited. The legend is ordered with the lowest number at the bottom and the highest at the top; it is not necessary for the numbers to be consecutive, but they must not be more than two digits long. When the top level entries have been ordered, the 'Ordering Level 2' form can be opened by clicking the appropriate button at the top of the form.

The 'Ordering Level 2' list shows entries in the second field in the 'Lithofacies units' table that have a common entry in the first field. The current entry in the first field appears just above the edit field. Thus, if the top level subdivision is by rock class into "Igneous", "Sedimentary" and "Metamorphic" categories and the second level is by age, the list will show all the age categories for igneous units when "Igneous" appears above the edit field. These can then be ordered, and separate ordering sequences must be made for the "Sedimentary" and "Metamorphic" categories.

The 'Ordering Level 3' list shows entries in the third field in the 'Lithofacies units' table that have common entries in the first two fields, and so on down to 'Lithofacies label'. On each list, the entries have to be numbered in the correct order. If a list only contains one entry, it is not necessary to number it because *GeoLegend* will automatically insert a default value of "1".

Clicking on the 'List records' button opens a list of all the records that determine the ordering sequence of the lithofacies legend and allows records to be deleted or exported by making selections from the 'View' or 'File' menus respectively. If a significant amount of reordering has to be done to the legend, it is usually easiest to delete all the records in the ordering table and start again by clicking the command button on the 'Lithofacies units: Entry form'.

Ordering numbers for tectonic divisions/subdivisions:

If categories have been designated with the key phrases "Tectonic division" and "Tectonic subdivision", separate ordering numbers should be entered for these two categories alone so that they can be used to sort stratigraphic legends when the tectonic option is chosen. The process is the same as for the complete lithofacies legend, except that only one or two categories are involved. Click the command button to start.

"Tectonic division" and "Tectonic subdivision" can be entered in both the 'Lithofacies units' and 'Tectonic assemblages' tables. Either set of entries, which need not be the same, can be accessed by stratigraphic legends when it is requested that these be sorted tectonically. Indicate which set of entries should be used by clicking the appropriate button on the 'Output Selection' form.

Open input table:

Clicking on one of these buttons opens the entry form for that table.

Go to "Output Selection":

Opens a form containing all the command buttons and menus required to generate a map, legend, and data and reference lists for a given area.

Select records:

Opens a dialogue box so that the user can select records with particular values of variables in the 'Lithofacies units' table. Note that the user-defined variables are listed in the 'Search this item' column as 'Level1', 'Level2' etc., and not by their user-defined names.

List lithofacies legend:

Opens a window showing a list of lithofacies units that meet the criteria defined in the 'Select records' dialogue box. The units are arranged in the order specified by their ordering numbers (*see* "Ordering numbers for complete lithofacies legend", above) and are formatted as a map legend.

Double-clicking on a record opens the entry form with that record showing; it can then be edited.

Long unit descriptions may be truncated on the form, but are given in full if the list is exported to a text file using either the 'Export All' or 'Export Selections' commands on the 'File' menu.

Update Note

Records can be deleted by choosing 'Delete All' from the 'View' menu, or by selecting records from the list and choosing 'Delete Selections'.

Check for duplicate records:

Checks the entire contents of the 'Lithofacies units' table for records that have the same 'Lithofacies label'. Only one of a duplicate pair is shown and this is not necessarily the one containing the mistake.

Revising 'Lithofacies label'

The 'Lithofacies label' field is the key that links the 'Lithofacies units' and 'Unit IDs' tables. If any of the labels in the 'Lithofacies units' table are changed, changes must be made to all records in the 'Unit IDs' table that have the same label in their 'Lithofacies label' field. Errors that arise from not doing this correctly can be found by clicking the 'Check lithofacies labels' button on the 'Unit IDs: Entry form'.

Ordering numbers must also be defined for new lithofacies labels by clicking the 'Ordering numbers for complete lithofacies legend' button, opening the form for lithofacies labels, and entering values as needed.

TECTONIC ASSEMBLAGES

The 'Tectonic assemblages' table has the same structure as the 'Lithofacies units' table. Refer to the latter for instructions on entering data.

STRATIGRAPHIC UNITS

Figure 7 shows the form used for entering information about each unit under the hierarchical scheme based on the stratigraphic code.

Entry Variables

Stratigraphic Variables

The first eight fields contain the names and letter-designations for units, as posted from the 'Unit IDs' table. These fields are referred to below as the "unit name fields". Collectively, the variables that they contain are the key linking the 'Unit IDs' and 'Stratigraphic units' tables in a many-to-one relationship. A record is identified uniquely in the 'Stratigraphic units' table by the combined contents of the eight unit name fields.

Values in the unit name fields are normally entered by clicking the button, 'Post unit names to Stratigraphic units table', on the 'Unit IDs: Entry form'.

Subsequent editing of the unit name fields is sometimes necessary, if changes are made to unit designations. For this purpose, it is possible to type into the fields. However, for the 'Supergroup' to 'Member' fields, it is preferable to enter values from the pop-up menus to ensure typographical accuracy. The menus contain all the values currently entered in the corresponding fields in the 'Unit IDs' table. If changes are being made to unit names, first make the changes in the 'Unit IDs' table and then make matching changes in the 'Stratigraphic units' table from the pop-up menus. Remember that, as linking fields, the unit name fields in the 'Unit IDs' and 'Stratigraphic units' tables must correspond.

Supergroup:

Name of the supergroup (or lithodemic equivalent) to which the unit belongs, if any.

Alphanumeric.

The field may be left empty subject to certain conditions (*see* "Note on unnamed units", in description of "Entry Variables" under "Unit IDs").

Group:

Name of the group (or lithodemic equivalent) to which the unit belongs, if any.

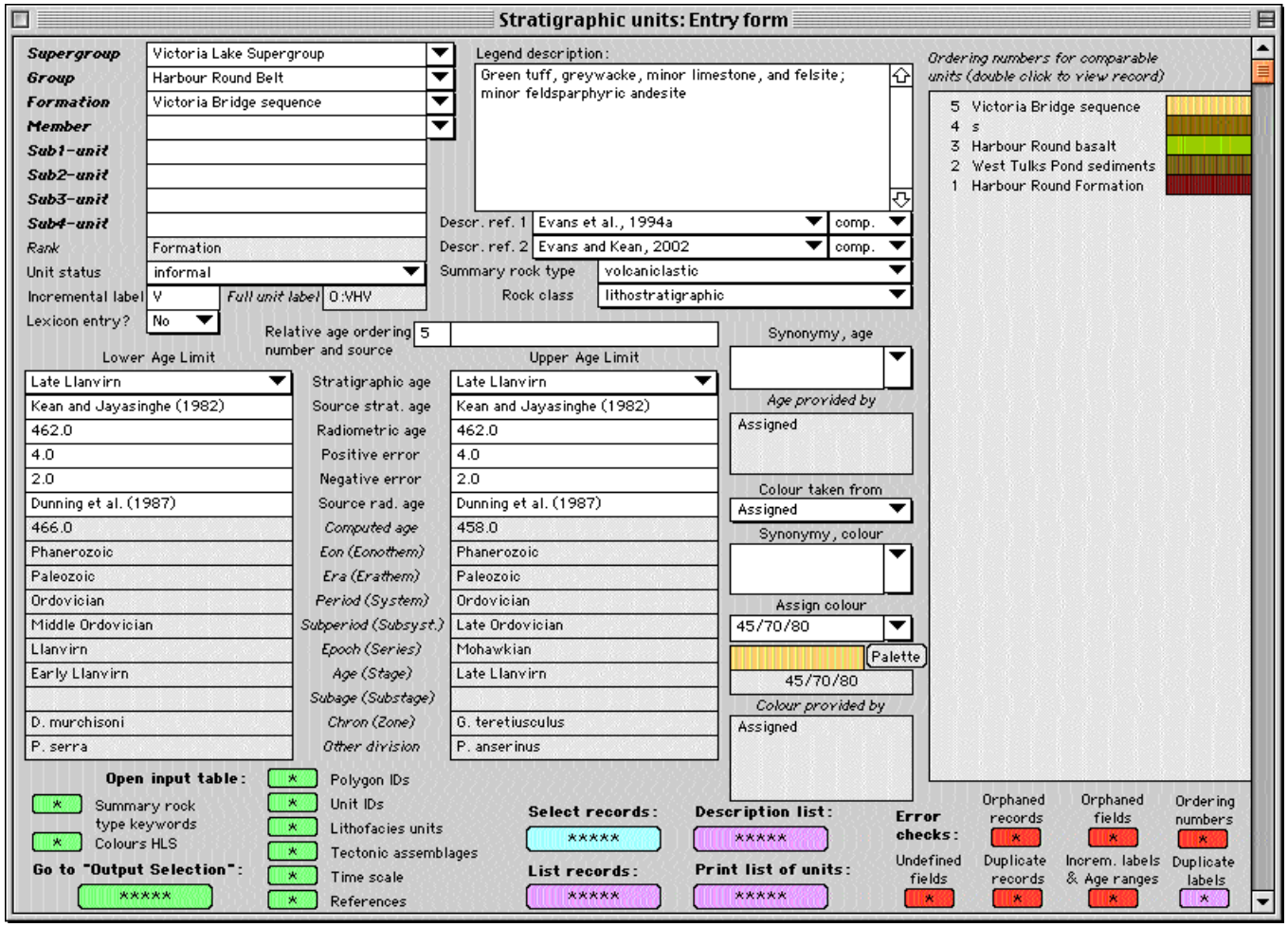

Figure 7. *'Stratigraphic units' table. Form used to enter legend information for stratigraphic units.*

Figure 7 is best viewed at 167% magnification

Alphanumeric.

The field may be left empty subject to certain conditions (*see* "Note on unnamed units", in description of "Entry Variables" under "Unit IDs").

Formation:

Name of the formation (or lithodemic equivalent) to which the unit belongs, if any.

Alphanumeric.

The field may be left empty subject to certain conditions (*see* "Note on unnamed units", in description of "Entry Variables" under "Unit IDs").

Member:

Name of the member (or lithodemic equivalent) to which the unit belongs, if any.

Alphanumeric.

The field may be left empty.

Sub1-unit:

A character, or characters, to identify the first level below 'Member' for a unit.

Alphanumeric.

The field may be left empty, unless a subunit of a lower rank is filled.

Sub2-unit:

A character, or characters, to identify the second level below 'Member' for a unit.

Alphanumeric.

The field may be left empty, unless a subunit of a lower rank is filled.

Sub3-unit:

A character, or characters, to identify the third level below 'Member' for a unit.

Alphanumeric.

The field may be left empty, unless 'Sub4-unit' is filled.

Sub4-unit:

A character, or characters, to identify the fourth level below 'Member' for a unit.

Alphanumeric.

The field may be left empty.

In order to avoid excessively long unit labels, the 'Sub4-unit' level should only be used when absolutely necessary. A unit at this level will usually have a label that is a minimum of five characters long (at least one for the age and for each subunit level).

Unit status:

The stratigraphic status of the unit ("Formal" or "Informal").

Alphanumeric.

The field may be left empty.

Values must be taken off the pop-up menu.

Incremental label:

The character (or characters) to be used on the unit label to represent the name or character in the lowest level unit name field that contains an entry.

Alphanumeric.

The field may be left empty.

The following example shows incremental labels for four related records:

Supergroup	Group	Formation	Member	Sub1-unit	Sub2-unit	Sub3-unit	Sub4-unit	Incremental label
	Buchans Group							B
	Buchans Group	Sandy Lake Formation						S
	Buchans Group	Sandy Lake Formation		v				v
	Buchans Group	Sandy Lake Formation		v	b			b

"B" represents "Buchans Group", "S" represents "Sandy Lake Formation", and "v" and "b" represent subunits 1 and 2 respectively. The incremental labels are strung together with an age label to produce the 'Full unit label' (*see below*).

Incremental labels for records that describe named units ('Supergroup' to 'Member') have to be entered by the user. The incremental labels for subunits are normally the same as the characters entered for them in the 'Unit IDs' table and posted to the unit name fields in the 'Stratigraphic units' table. Subunit labels are entered automatically but can be changed. If you decide to change the character denoting a subunit, remember to change its 'Incremental label' too; this will not happen automatically but can be checked with the 'Incremental label' error check button. Sub1-units that are enclosed in (round brackets) and are used to allow special sorting of subunits on legends default to an empty 'Incremental label' field; the field should be left empty (*see* "Relative age ordering number" under "Age Variables", below).

Unnamed units in the 'Unit IDs' table that use a unit designator in the 'Formation' field enclosed in (round brackets) will generate a separate record in the 'Stratigraphic units' table for this "dummy" formation. The 'Incremental label' field should be left empty in this record but should be filled in the records describing subunits of the "dummy" formation (*see* "Note on unnamed units", paragraph 3, in description of "Entry Variables" under "Unit IDs").

The 'Incremental label' field may also be left empty if you do not want a particular level in the hierarchy to be denoted in unit labels. For example, you may want surficial deposits to be simply denoted by 'Q'. The letter 'Q' is generated as the age label for the Quaternary by the age variables described below. An entry in the 'Incremental label' field would be placed after it, but leaving this field empty produces a label that consists of the age label only.

Lexicon entry?:

Whether or not the unit has an entry in the stratigraphic lexicon, or similar publication, for the region ("Yes" or "No").

Flag.

The field may be left empty.

Values must be taken off the pop-up menu.

Lithologic Variables

Legend description:

The legend description for a unit.

Alphanumeric.

The field may be left empty.

A description should be entered for all units with the following exception. Unnamed units that use a unit designator in the 'Formation' field enclosed in (round brackets) have a separate record at the 'Formation' level for this "dummy" formation. The 'Legend description' field should be left empty in this record but should be filled in the records describing subunits of the "dummy" formation (*see* "Note on unnamed units", paragraph 3, in description of "Entry Variables" under "Unit IDs").

A record for a "dummy" sub1-unit, as described under 'Relative age ordering number' above, should use the description for the record immediately senior to it.

At the lowest level in the stratigraphic hierarchy, legend descriptions can usually be taken directly from published geological maps. If there are several descriptions to choose from, the most informative should be used; if the descriptions seem to have significantly different content, this may be an indication that units have been equated that should not have been equated. Descriptions for more senior units may never have appeared on a map legend; these can usually be compiled by combining descriptions from junior units. The Lexicon of Canadian Stratigraphy and similar publications are good sources of descriptions for the highest level units.

References to other units may appear in unit descriptions. If possible, these should refer to the other units by name rather than by unit label, because the actual labels are easily changed by revisions to incremental labels, age information, or the time scale. References to unit labels in legend descriptions are not updated when such revisions are made.

Description reference 1:

A short-form reference for the description of the unit.

Alphanumeric.

The field must be filled, if the 'Legend description' field is filled. The record cannot be entered unless it is.

Values can only be entered off the pop-up menu. This menu contains all references currently entered into the 'References' table and, if the appropriate reference is not on the menu, it must be entered into the 'References' table first.

Up to two references can be entered for a record. If there are more than two references for the description, enter "various sources" (*see* "Various Sources Record" under "References", below).

References are printed on the legend at the end of each description. This is necessary because individual units may extend across the boundaries of several source maps, each of which will have its own unit description. Since only one description can be entered for a unit into *GeoLegend*, the description that is applied to a particular unit on a particular map may not have been written by the same person who produced the linework.

The field can be flagged as either "verb.", for verbatim , or "comp.", for compiled. Except when "various sources" is chosen "verb." is the default value and the short-form reference will be printed at the end of the legend description without any prefix; "verb." indicates that the description is copied unchanged from the source document. If the description is significantly changed from the source document, "comp." should be chosen and this will prefix the reference, e.g., "(comp. Bostock *et al*., 1983b)".

Description reference 2:

A short-form reference for the description of the unit.

Alphanumeric.

The field may be left empty; it can only be filled if 'Description reference 1' is filled first.

Entry and flagging is the same as for 'Description reference 1', above.

Summary rock type:

A keyword summary description of the lithology of a unit.

Alphanumeric.

The field may be left empty.

Values can only be entered off the pop-up menu. This menu contains keywords that have been entered into the 'Summary rock-type keywords' table, which is accessed by a command button at the bottom of the 'Stratigraphic units: Entry form'. The same keyword list is used by an analogous field in the 'Lithofacies units' table.

Keywords are best set up in a hierarchical fashion (e.g., "volcanic mafic marine") so that they can be searched at different levels of the hierarchy. The 'Summary rock-type keywords' table allows for an initial division of units by rock class, e.g., "igneous", "metamorphic" or "sedimentary".

For many units, especially more general stratigraphic divisions, a keyword is an oversimplification of the various rock types that may exist in the unit; a keyword that most closely represents the characteristic rocks within the unit should be chosen.

Rock class:

The principal morphological rock class of the unit.

Alphanumeric.

The field may be left empty, but must be filled if it is intended to produce legends that are sorted by rock class.

Values must be taken off the pop-up menu.

Legends are sorted into two categories, "Lithostratigraphic units" and "Lithodemic units". "Intrusive", "Complex" and "Other lithodemic" units are lumped together on legends in the lithodemic category.

Age Variables

The age of a unit is used to build a unit label, and to sort units and provide age titles in the legend. Geologists describe the age of a unit in three ways: (a) absolute age, usually derived by radiometric dating and stated in millions or billions of years, (b) stratigraphic age, such as Ordovician or *Didymograptus clingani* Zone, and (c) relative age, based on the Law of Superposition, intrusive relationships or similar criteria. Absolute and stratigraphic ages are interchangeable through the medium of the geological time scale stored in the 'Time scale' table, but they do not have enough resolution to sort most legends. Relative age is important for sorting legends but does not provide information for unit labels or age titles.

Age data are entered into fifteen fields and produce a further twenty computed fields in the 'Stratigraphic units' table.

Relative age ordering number:

A number used to order units on legends; low numbers plot below high numbers in any comparable set of units.

Numeric. Integer, with a maximum length of two digits.

The field should always be filled; if no specific entry is made, the field automatically defaults to "1".

GeoLegend determines which units need to be sorted relative to the unit currently shown on the entry form and displays these, along with the current unit, on the subform 'Ordering numbers for comparable units…' at the right of the entry form. Enter ordering numbers for the current unit and comparable units so that these units appear in their preferred legend order. The subform is only updated when the 'Replace' or 'Enter' commands have been made for the record. Comparable units can be easily accessed by double-clicking them on the subform.

Using relative ages to sort stratigraphic hierarchies:

GeoLegend sorts legends first by ordering the various stratigraphic hierarchies and then by sorting units at various levels within each hierarchy.

It sorts the various hierarchies by comparing the absolute and/or stratigraphic ages of the top level units for each hierarchy and sorting in ascending order of the lower age limits. If the lower age limits for two hierarchies are the same, it sorts using the upper age limits. If both lower and upper age limits are the same for two hierarchies, they must be given different values in 'Relative age ordering number'.

In most cases, units at the top of a hierarchy are distinguished successfully by their lower and upper age limits and the 'Relative age …' field can be allowed to default to 1. When such a unit is shown on the entry form, the 'Ordering numbers…' subform contains a single entry for that unit and only that unit.

In cases, where the unit at the top of the hierarchy has the same age limits as other units at the tops of their hierarchies, these other units will also appear on the subform, along with the ordering numbers assigned to them. Each unit must be assigned a different ordering number, either to reflect a real age difference or simply to define an order on the legend. Comparable units with the same ordering numbers appear on legends in a random order and their subdivisions are randomly mixed together.

The contents of the 'Stratigraphic units' table can be checked for ambiguous ordering numbers by clicking on the 'Ordering numbers' command button under 'Error checks'.

Using relative ages to sort units within hierarchies:

When *GeoLegend* sorts units that are not at the top of a hierarchy, it relies entirely upon the relative age ordering numbers, irrespective of what absolute or stratigraphic age information is available. When a subsidiary unit is showing on the entry form, the comparable units that show on the subform and need to be ordered are those having the same immediate parent (*see below* for exceptions regarding subunits). For example, when the "Sandy Lake Formation" of the "Buchans Group" is shown on the entry form, all other formations of the Buchans Group appear with it on the subform. Units of the Buchans Group that are defined at the 'Sub1-unit' level only appear with the formations if they are direct subdivisions of the group and do not belong to a formation or member.

Normally relative age ordering numbers are assigned so that units within a hierarchy are sorted by absolute age. However, there are exceptions. For

example, if units are structurally stacked within an allochthon, it may be more logical to order them according to the structural stacking sequence, which may be the reverse of the age sequence.

Using relative ages to sort subunits:

The strict hierarchical sorting used for units at the 'Sub1-unit' level and above is not used below the 'Sub1-unit' level. When a unit defined at the 'Sub2-unit' level is displayed, all units that are subdivisions of the same sub1-unit are displayed on the subform as comparable units, whether they are direct subdivisions of the sub1-unit or are at a lower level. They are shown as character strings from 'Sub1-unit' downward. This arrangement allows much more flexibility in the sorting of subunits and is necessary because subunits are generally lithological divisions that are not subject to the same structured hierarchy as stratigraphic divisions. The following examples illustrate how sorting orders can be manipulated:

1. The Pennys Brook Formation is divided at the 'Sub1-unit' level into younger sedimentary and older volcanic units, "s" and "v" respectively. When the 'Sub1-unit' level is current, the subform shows

2	s
1	v

   and all sedimentary units plot above all volcanic units on the legend.

2. The volcanic units are divided at the 'Sub2-unit' level into mafic, "m", and felsic, "f", each of which are further subdivided at the 'Sub3-unit' level into flows, "f", and pyroclastics, "p". When a sub2-unit or sub3-unit is current, the subform shows all units below the sub1-unit level and allows them to be sorted in any order relative to each other, e.g.,

6	vmp
5	vfp
4	vmf
3	vff
2	vm
1	vf

   Note that this arrangement allows mafic and felsic subdivisions to alternate, whereas it is not possible to alternate the sedimentary and volcanic subunits, as entered, because the distinction between these two packages was made at the 'Sub1-unit' level.

3. If it is necessary to alternate the sedimentary and volcanic units, they must be distinguished at the 'Sub2-unit' level. This is done by using a

"dummy" unit at the 'Sub1-unit' level. The "dummy" unit is enclosed in round brackets, e.g., "(u)". The Pennys Brook Formation now has a single sub1-unit, "(u)". When a 'Sub1-unit' character is enclosed in round brackets, the 'Incremental label' field defaults to empty; it is left empty so that "(u)" does not show up as part of the unit label. Sub1-unit "(u)" is given the same description and description reference(s) as the Pennys Brook Formation at the 'Formation' level. The sedimentary and volcanic units are then entered at the 'Sub2-unit' level (1 and 9 below). At this level, the subform shows all the subunits for the Pennys Brook Formation together and allows them to be sorted in any order:

10	(u)vmp
9	(u)s
8	(u)sb
7	(u)vfp
6	(u)vmf
5	(u)sr
4	(u)vff
3	(u)vm
2	(u)vf
1	(u)v

Source of relative age:

A reference or other note to indicate the source of relative age information to the compiler of the database.

Alphanumeric.

The field may be left empty.

Stratigraphic age:

Two fields for stratigraphic intervals used to determine the lower and upper age limits of a unit, respectively.

Alphanumeric.

The fields may be left empty.

A stratigraphic interval is entered by selecting a name on the respective pop-up menu. The menus show every stratigraphic interval that has been defined in the 'Time scale' table. Entries cannot be typed into the fields and intervals that are not on the menus must first be entered and defined on the 'Time scale' table.

GeoLegend converts stratigraphic ages into millions of years using the 'Time scale' table. For lower limits, it uses the age of the base of an interval and, for upper limits, it uses the age of the top of an interval.

Source stratigraphic age:

References or other notes to indicate the sources of stratigraphic age information to the compiler of the database.

Alphanumeric.

The fields may be left empty.

Radiometric age:

Two fields for radiometric ages used to determine the lower and upper age limits of a unit, respectively.

Numeric. Values must be between "0" and "4600".

The fields may be left empty.

GeoLegend adjusts radiometric ages by their error estimates. For lower limits, it adds the 'Positive error' to the age and, for upper limits, it subtracts the 'Negative error'.

Positive error:

Two fields in which are entered the positive error estimates for ages entered in the 'Radiometric age' fields.

Numeric. Values must be between "0" and "4600".

The fields may be left empty.

Negative error:

Two fields in which are entered the negative error estimates for ages entered in the 'Radiometric age' fields.

Numeric. Values must be between "0" and "4600".

The fields may be left empty.

Source radiometric age:

References or other notes to indicate the sources of radiometric age information to the compiler of the database.

Alphanumeric.

The fields may be left empty.

Synonymy, age:

An entry that allows units in one stratigraphic hierarchy to access age information in another hierarchy (*see* "Notes on stratigraphic and radiometric ages", below).

Alphanumeric.

The field may be left empty.

Values can be typed in, but when a value is present on one record, it appears on the pop-up menu and should thereafter be entered by selecting it from the menu.

Notes on stratigraphic and radiometric ages:

1. For all operations involving stratigraphic or radiometric ages, *GeoLegend* uses an age in millions of years calculated from the stratigraphic and radiometric age limits. If there are entries for both radiometric and stratigraphic lower age limits, it uses the older of these. If both types of age are entered for the upper limit, it uses the younger. It is useful to enter both radiometric and stratigraphic age limits, if these are available, because the one that is actually used may change, if changes are made to the time scale. The actual ages being used are shown, in millions of years, as the 'Computed age'.

2. The same entries may be made for both the lower and upper age limits. If a radiometric age of 513 +/-2 is entered in both sets of radiometric fields, the 'Computed age' of the base is "515.0" and the 'Computed age' of the top is "511.0". If "Ordovician" is entered for both the base and the top, the 'Computed age' for the base is the base of the Ordovician, "489.0", and for the top, the top of the Ordovician, "443.0" (Okulitch, 2001).

3. If a lower age limit is entered, for example "Ordovician", but there is no entry for an upper limit, *GeoLegend* interprets this as meaning that

the unit is "Ordovician or younger" and the label for the unit starts with "<O". If the upper limit is filled but not the lower, the unit is "Ordovician or older" and the label starts ">O".

4. Most units do not have direct age information of their own, they are simply known to fall somewhere within the age range determined for some senior unit. There is no need to fill in age information for each unit in a stratigraphic hierarchy. If no information is entered for a unit, *GeoLegend* searches up the hierarchy of the unit (except if there is an entry in the 'Synonymy, age' field, *see* "5", below) and the computed ages default to those for the first unit that has entries. Note that all the fields for both the lower and upper limits must be empty for such a search to occur.

5. *GeoLegend* also searches for an age in other units that are considered to be the same age as the current unit or one of its senior units; this sideways search is enabled by making the same entry in the 'Synonymy, age' field for the two units of equivalent age. For example, only one set of age information is entered for all the units in the Buchans and Roberts Arm groups because the two groups are considered to be lateral equivalents. The age information is entered in the record for the Buchans Group and "Buchans Group" is entered in the 'Synonymy, age' field on both this record and on the record for the Roberts Arm Group. All units in the Roberts Arm Group search up the stratigraphic hierarchy until they come to the record describing the group itself, which directs them to take age information from the Buchans Group. All units in the Buchans Group search up their stratigraphic hierarchy and take their age from the same record. Note that the record that is accessed by a 'Synonymy, age' entry must have directly entered age information; *GeoLegend* will not search up a linked hierarchy. The two records that are linked need not be of the same stratigraphic rank.

6. *GeoLegend* gives precedence to directly entered age data. It ignores entries in 'Synonymy, age' for records that have their own age information.

7. *GeoLegend* checks for 'Synonymy, age' links at every level of the hierarchy and will not move farther up a hierarchy if it finds one. For example, if there is a link in a record at the formation level, a unit at this level and all units below it will take their ages from the record indicated by the link. They will not default to age information provided at the top of their own hierarchy, at perhaps the group level.

8. Every unit must have stratigraphic and/or radiometric age information available to it, either directly or by default. As a minimum

requirement, therefore, the record at the top of each stratigraphic hierarchy must have directly entered age information or an entry in the 'Synonymy, age' field.

Colour Variables

Colour taken from:

A keyword indicating where the colour for a unit should be taken from.

Alphanumeric.

The field must be filled. If no entry is made, the field defaults to "Assigned", which only returns a colour if an HLS value has been entered in the 'Assign colour' field.

Values must be taken off the pop-up menu. Entering "Parent unit" returns the colour of the next unit up the stratigraphic hierarchy. "Synonym" returns the colour of the unit which has the same entry as the current unit in 'Synonymy, colour' and has "Assigned" in its 'Colour taken from' field. "Assigned" returns the colour indicated by the HLS value entered in the 'Assign colour' field.

The colour returned is shown in the computed field next to the 'Palette' command button. Its HLS value is shown immediately below this field. The colour is also shown on the subform 'Ordering numbers for comparable units…' on the right side of the entry form, along with the colours of comparable units. This allows easy comparison of colours that will commonly occur close to each other on a map.

The computed variable, 'Colour provided by', shows which unit provides the colour for the current unit and actually has the HLS value for this colour in its 'Assign colour' field. Changing the HLS value in this one record will change the colour for all units that depend on it through a parent or synonym relationship.

Synonymy, colour:

The field allows units to access the colour entered for another unit anywhere in the 'Stratigraphic units' table.

Alphanumeric.

The field may be left empty.

Values can be typed in, but when a value is present on a record with an assigned colour, it appears on the pop-up menu and should be entered by selecting it from the menu.

To use 'Synonymy, colour', a "source" unit must be set up. In the "source" unit, enter "Assigned" in the 'Colour taken from' field, an HLS value in the 'Assign colour' field, and an identifying name in the 'Synonymy, colour' field. For any unit that you want coloured the same, enter "Synonym" in the 'Colour taken from' field and choose the same identifying name from the menu in the 'Synonymy, colour' field. For example, you may wish to have all ultramafic units in ophiolite complexes coloured purple. Choose one of these units and set it up as the "source" unit with "Ophiolite ultramafic" entered in the 'Synonymy, colour' field, the HLS value for purple in the 'Assign colour' field, and "Assigned" in the 'Colour taken from' field. Then, in all the other records, you can just choose "Synonym" and "Ophiolite ultramafic" from the two menus instead of having to find and enter the correct HLS value.

Assign colour:

The colour to be used for the unit on plotted maps, expressed numerically using the HLS colour system (hue, lightness, saturation).

Alphanumeric.

The field may be left empty.

Values can be typed in but this is not the preferred entry method. In most cases, colours should be entered from the 'Colour palette' or from the pop-up menu.

To enter a colour from the 'Colour palette', click on the 'Palette' command button. Find the required colour on the 'Colour palette' and double click on it. This opens a window called 'Colour value'. Select and copy the HLS value in this window and paste it into the 'Assign colour' field. Note that various sort orders are available for the 'Colour palette' under the 'Set' menu.

Colours that have been entered in the 'Lithofacies units' and 'Tectonic assemblages' tables appear on the pop-up menu. Each menu item shows a unit label and the corresponding HLS value, but only enters the HLS value in the field. These colours for units on regional maps can often be used as a guide for colouring the main stratigraphic hierarchies.

Computed Variables

Rank:

The stratigraphic rank of the unit described on the record. It is the same as the name of the lowest unit name field that has an entry.

Full unit label:

The map label for a unit, which is computed by stringing together character(s) representing the age of the unit with incremental labels for each level in the unit's stratigraphic hierarchy. A colon separates the age portion of the label from the incremental labels:

S'gp	Group	Formation	Member	Sub1 unit	Sub2-unit	Sub3-unit	Sub4-unit	Increm'l label	Full unit label
	Buchans Group							B	O:B
	Buchans Group	Sandy Lake Formation						S	O:BS
	Buchans Group	Sandy Lake Formation		v				v	O:BSv
	Buchans Group	Sandy Lake Formation		v	b			b	O:BSvb

Age portion of full unit labels:

Letters representing the age of a unit ("O" for Ordovician in the above example) are determined using age information entered for the unit in the 'Stratigraphic units' table and referred to the 'Time scale' table (*see below*). If new age information becomes available for the unit, this can be entered in the 'Stratigraphic units' table and the unit labels will be automatically adjusted. If the geological time scale is changed, the changes can be entered in the 'Time scale' table and all labels for affected units will be adjusted.

Letters indicating age refer to eons or eras in the Archean, eras or periods in the Proterozoic, periods or subperiods in the Paleozoic and Mesozoic, and periods or epochs in the Cenozoic. For example, if the lower and upper age limits of a Paleozoic unit fall entirely within a single subperiod, e.g., Middle Ordovician, the symbol for the subperiod, "mO", is used in the label. If the age limits straddle two or more subperiods within the same period, e.g., Early to Late Ordovician, the symbol for the period, "O", is used. If the age limits straddle two adjacent periods, e.g., Late Ordovician to Early Silurian, the two period symbols are placed together, "OS". If the age limits straddle three or more periods, e.g., Cambrian to Early Silurian, the symbols for the beginning and end periods are separated by a hyphen, "C-S".

Editing labels:

Because the part of a label representing age is a floating value and the number of combinations for a label is fairly limited, there is always the pos-

sibility that two different units on the same map may have the same label. If this happens, the problem is easily corrected by changing one of the incremental labels for a unit. Opening the record for the Buchans Group, in the above example, and changing the incremental label from "B" to "U" will also change the labels of all the subdivisions of the Buchans Group. For operations within *GeoLegend*, units are not identified by their labels, which may not be unique, but instead by the full names appearing in the eight unit name fields.

GeoLegend can be checked for duplicate labels by clicking the 'Duplicate labels' button in the 'Error checks' section of the 'Stratigraphic units' entry form.

Computed age:

The ages in millions of years used by *GeoLegend* for operations requiring age information.

For entries in the stratigraphic fields, the computed age is the absolute age of the base of an interval for lower limit entries, and the top of an interval for upper limit entries. For entries in the radiometric fields, it is the radiometric age plus the positive error for lower limit entries, and the radiometric age minus the negative error for upper limit entries.

If there are entries for both radiometric and stratigraphic lower age limits, the computed age is the older of these. If both types of age are entered for the upper limit, the computed age is the younger.

Eon (Eonothem) to Other division:

Two sets of computed variables show the time intervals in which the lower and upper age limits of a unit fall. Only time intervals defined in the 'Time scale' table are displayed. In the case of lower ranked time intervals, more than one interval may be defined in the 'Time scale' table for a particular computed age but only one of these can be displayed.

Age provided by:

Indicates the source of age information being used for the record.

If age information is entered directly into the record, the variable returns "Assigned". If the age information is derived from a record farther up the stratigraphic hierarchy, the variable shows the rank of that record. If the age information is derived by using 'Synonymy, age', usually from a record in a

different hierarchy, the variable shows the values entered into the 'Supergroup' to 'Sub4-unit' fields in that record.

Colour and HLS value:

These computed variables are not labeled. They are located beside and below the 'Palette' command button. The 'Colour' variable shows an image of the colour that has been chosen for the unit, provided this colour has been entered in the 'Colours' table. 'HLS value' expresses the colour as a set of three numbers in the HLS colour system. The colour image is also shown on the subform 'Ordering numbers for comparable units…', along with the colours of comparable units.

Colour provided by:

Indicates the source of the colour being used for the record.

If "Assigned" is entered in the 'Colour taken from' field, the variable returns "Assigned". If the colour is derived from a record farther up the stratigraphic hierarchy, the variable shows the rank of that record. If the colour is derived by using 'Synonymy, colour', usually from a record in a different hierarchy, the variable shows the values entered into the 'Supergroup' to 'Sub4-unit' fields in that record.

Command Buttons

Palette:

Click the button to open the 'Colour palette' (*see* "Assign colour", above).

Open input table:

Clicking on one of these buttons opens the entry form for that table.

Open input table: Summary rock-type keywords:

This button opens a form for entering and editing rock-type keywords. The keywords will then appear on the pop-up menu in the 'Summary rock type' field and can be entered for individual units. If you do not want to use the 'Summary rock type' field, there is no need to fill in the 'Summary rock-type…' table.

Keywords are typed into the second field on the form ('Keyword'), which is alphanumeric and can be left empty. They are sorted alphabetically on the list shown below the entry fields, and on the pop-up menu.

If you want keywords to be broken up into groups by rock class, choose one of the petrologic rock classes from the pop-up menu in the first field, 'Rock class'. This field is alphanumeric and can be left empty. The 'Rock class' field can be typed into if categories other than those on the pop-up menu are needed (e.g., morphological rock classes such as "intrusive", "stratified" etc.). Categories are sorted alphabetically.

Categories can be clearly separated on the pop-up menu, if each category (except the first) includes a record that consists of a line of non-alphabetic characters such as hyphens.

Go to "Output Selection":

Opens a form containing all the command buttons and menus required to generate a map, legend, and data and reference lists for a given area.

Select records:

Opens a dialogue box so that the user can select records with particular values of variables in the 'Stratigraphic units' table.

List records:

Opens a window showing a list of records that meet the criteria defined in the 'Select records' dialogue box.

Double-clicking on a record opens the entry form with that record showing; it can then be edited.

Records can be exported to a text file by choosing 'Export All' from the 'File' menu, or by selecting records from the list and choosing 'Export Selections'.

Records can be deleted by choosing 'Delete All' from the 'View' menu, or by selecting records from the list and choosing 'Delete Selections'.

Description list:

Opens a window showing a list of records that meet the criteria defined in the 'Select records' dialogue box. The list contains legend descriptions, as well as age information and incremental labels. It provides a convenient way to export the legend descriptions so that they can be edited in a word processor, which is often a more suitable environment for dealing with large numbers of text blocks.

Export the descriptions by choosing 'Export all' from the 'File' menu. The text file should then be formatted with two global changes. First change all carriage returns to two successive carriage returns. Then change all horizontal tabs to single carriage returns.

When the legend descriptions have been edited, they can be entered into *GeoLegend* using the 'Copy' and 'Paste' commands on the 'Edit' menus of the word processor and Helix RADE™.

Print list of units:

Prints a list of records in the 'Stratigraphic units' table that meet the criteria defined in the 'Select records' dialogue box.

Error checks:

All error checks apply to the entire contents of the 'Stratigraphic units' table, not just the records that meet the 'Select records' criteria.

Undefined fields:

Checks for units in which one or more of the following fields have not been filled:

'Unit status'
'Incremental label' (except records for "dummy" units)
'Lexicon entry?'
'Summary rock type' (except records for "dummy" units)
'Rock class'
'Colour taken from'

Orphaned records:

Checks for records that have no corresponding combinations of the eight unit name fields, from 'Supergroup' to 'Sub4-unit', in the 'Unit IDs' table. In most cases, this is because the record in the 'Unit IDs' table has been deleted for some reason. If it was deleted intentionally, then the record(s) in the 'Stratigraphic units' table can also be deleted.

Duplicate records:

Checks for records that have duplicate combinations of the eight unit name fields from 'Supergroup' to 'Sub4-unit'. Only one of a duplicate pair is shown and this is not necessarily the one containing the mistake.

Orphaned fields:

Checks fields that contain values entered from menus and looked up from records in the 'References', 'Time scale' and 'Stratigraphic units' tables. Records are listed if any of the fields are unable to find source records with matching values. This problem most commonly arises when the source records have been changed or deleted since the contents of the linking field were entered. Fields causing errors have a yellow background on the list. Correcting an error involves either changing the contents of the field or changing/entering a source record.

The two reference fields look for matching short-form references in the 'References' table. If the problem is not corrected, the short-form reference is printed in place of the full reference on all reference lists. The stratigraphic age limits look for matching values in the 'Time interval' field in the 'Time scale' table. The problem may cause the unit to appear in the wrong place on the legend and its label may have no age component. The synonymy fields look for matching values in the same fields in other records of the 'Stratigraphic units' table. An error in 'Synonymy, age' may misplace a unit in the legend and fail to generate an age component for its label. An incorrect 'Synonymy, colour' causes a unit to have no colour.

Incremental labels and Age ranges:

First, checks for units at the 'Sub1-unit' level or below, in which the character(s) in the lowest subunit is not the same as the character(s) in 'Incremental label'. It is not required that they be the same but it is recommended.

Secondly, checks that the age ranges of units lie entirely within the age ranges of their parent units. Errors may arise if age information is entered for a unit that does not lie at the top of its hierarchy. Usually it is necessary to expand the age range of the parent unit, which must, by definition, encompass the age ranges of all its subsidiary units.

Ordering numbers:

Checks for records that have duplicate age information used for sorting legends. These may be units at the tops of stratigraphic hierarchies that have the same lower and upper age limits and the same 'Relative age ordering number'. Alternatively they may be subsidiary units that have the same parent unit and the same 'Relative age ordering number'. Only one of a duplicate pair is shown and this is not necessarily the one containing the mistake. The units should be given different ordering numbers.

Note that this check can be time consuming for a large dataset. It is best to print the list and close it before making changes.

Duplicate labels:

Checks for duplicates of the computed variable 'Full unit label'. The check takes some time to complete on a large database because the label must be calculated for every record and written to a temporary file. For example, a Macintosh G4 takes about 2 hours to update the checker, if there are about 2000 records in the 'Stratigraphic units' table. Duplicate labels are of no concern in the ordinary running of the database because units are distinguished by their names, not their labels. However, they will probably be confusing if they appear together on the same map.

Clicking on the 'Duplicate labels' button opens a control window. If new data have been entered into the 'Stratigraphic units' table since the last check, perform an update by clicking the 'Update Label Checker' button. Once this procedure has been completed, you can examine the results at your leisure by clicking on the other buttons.

Two variations of the unit label are shown, one without "pipes" (|) and one with. The former are the normal labels that are traditionally used on geological maps. In the latter, pipes are inserted for each of the eight levels of the stratigraphic hierarchy. This type of label produces fewer duplicates because it distinguishes labels that use the same characters but at different stratigraphic levels (e.g., "O:GHa" could become "O:G||H||a||||", if "G" stands for a supergroup, or "O:|G|H||a||||", if "G" is a group). *GeoLegend* is set up to use labels without pipes, but if your application would work better with pipes, this can easily be implemented. Contact the author.

Clicking on the button 'Duplicate Labels (No Pipes)' produces a list containing the second record of each duplicate pair. The centre column shows the labels without pipes and the list is sorted by these alphabetically. The left column shows the equivalents with pipes, and the right column shows the concatenated contents of the eight unit name fields, which *GeoLegend* uses to identify the records. Clicking on the button 'Duplicate Labels (Pipes)' produces a similar list for records with duplicate labels when pipes are inserted.

The best way to resolve duplicate labels is to print the 'Duplicate Labels…' list and then investigate each pair using the 'Complete List'. When you open this list, you are given a choice of sort orders, depending on whether you are using pipes or not. You can toggle between them using 'Sort Order' under the 'Set' menu. The list shows all the units in the 'Stratigraphic units' table, except "dummy" units, sorted alphabetically by the chosen label type. Records that have been added to the 'Stratigraphic units' table since the

last update of the label checker appear at the top of the list and have no labels. Pairs of duplicate labels occur together and the second in each pair is highlighted by a yellow background.

Many duplicate labels may actually be different if case is taken into account. On geological maps, a difference in case is normally considered to be sufficient distinction between labels, but database and GIS software is commonly not case sensitive. Therefore, distinction on case alone may or may not be a problem, depending on the software you are using with *GeoLegend*.

Resolving other duplicate pairs usually means changing the 'Incremental label' for a record. Remember that such a change affects all the labels lower down in the same stratigraphic hierarchy. Changes are not reflected on the 'Duplicate Labels…' lists until these are updated.

Two kinds of duplicate label are not flagged by the error check because they are generated by "dummy" records and have no repercussions within *GeoLegend* or its output. They may, however, have repercussions if the raw data are exported to other software.

The first kind may arise from the "dummy" records that occur at the tops of hierarchies containing no named units. These records have entries in the 'Formation' field, enclosed in round brackets, and all the other unit name fields are empty. They have age information, which generates the age part of a label, but they do not have entries in 'Incremental label'. The first record in the hierarchy to have an incremental label and legend description, and to be applied to a real map unit, is at the 'Sub1-unit' level. Several of these "dummy" units may generate the same age label and their labels would then not be unique. Within *GeoLegend* and its output, this is unimportant because the labels are never assigned to real map units.

The second kind occurs when the 'Sub1-unit' level in a hierarchy is occupied by a "dummy" record signified by a character in round brackets (e.g., (u); *see* "Using relative ages to sort stratigraphic hierarchies" under "Age Variables", above). The incremental label is left blank and the full label for this unit is, by definition, identical to that for the unit just above it in the same hierarchy. However, so too are the contents of the descriptive fields and it is therefore of no consequence if the two records are interchanged.

Processing Stratigraphic Units

After posting unit names from the 'Unit IDs' table, the 'Stratigraphic units' table will contain a series of records in which the eight unit name fields are the only fields that are filled. For these records, use the entry form to fill

in the various fields described above in "Entry Variables". In particular, make sure that the 'Incremental label' field is filled (except under special circumstances described above) and that every unit has stratigraphic and/or radiometric age data available to it, either by entry or by default. Units with no access to age data will have no values showing in either of the 'Computed age' fields.

When entering new data, it is often convenient to use the 'Undefined fields' button to select only those records that need entries. An alternative method, which allows more flexibility, is to use the 'List records' window. In this window, all new records that have not previously been opened have empty 'Relative age ordering number' fields. It is easy to scan down the list for these and then to open an individual record by double clicking on it.

After you have entered all necessary information into the various entry fields, the records should be checked for errors by clicking the seven buttons for 'Error checks' at the bottom of the entry form. Checks for orphaned and duplicate records, undefined and orphaned fields, and incremental labels can be made routinely. The checks for ordering numbers and duplicate labels are more time consuming and are best done when a dataset is about to be used to produce output.

Revising the Eight Unit Name Fields

The entries in the eight unit name fields sometimes need to be revised. Special care must be taken in making such revisions because these variables provide the link with the 'Unit IDs' table. Any changes must be matched by corresponding changes in the 'Unit IDs' table.

The best way to make changes in the 'Supergroup' to 'Member' fields is to enter the changes in the 'Unit IDs' table first and then to use the pop-up menus to do the editing in the 'Stratigraphic units' table. The pop-up menus only contain values that occur in the 'Unit IDs' table and so prevent the introduction of typographical errors.

Revisions should be checked for accuracy by:

1. Posting from the 'Unit IDs' table to the 'Stratigraphic units' table; unmatched records in the 'Unit IDs' table will show up as new records in the 'Stratigraphic units' table, which can be quickly spotted by clicking the 'Undefined fields' button.

2. Checking for orphaned records in the 'Stratigraphic units' table; unmatched records in the 'Stratigraphic units' table will be listed on the orphaned record list.

TIME SCALE

Figure 8 shows the entry form for time scale information. The 'Time scale' table makes it easy to adjust maps and legends for changes in the calibration of the geological time scale. Any changes entered into the table are immediately reflected in the age component of unit labels and in the organization and age titles of legends. Once set up for a particular region, the table is unlikely to need frequent revision.

The 'Time scale' table performs two basic functions. First, it translates entries in the 'Stratigraphic age' fields of the 'Stratigraphic units' table into numeric ages, which can be used by *GeoLegend* for comparison and sorting purposes. Second, it translates numeric ages in the 'Computed age' fields of the 'Stratigraphic units' table into the stratigraphic ages needed for legend headers and the age component of unit labels. Records needed for the latter function must obey certain rules to ensure that they return the correct values. These records are referred to below as the "label records".

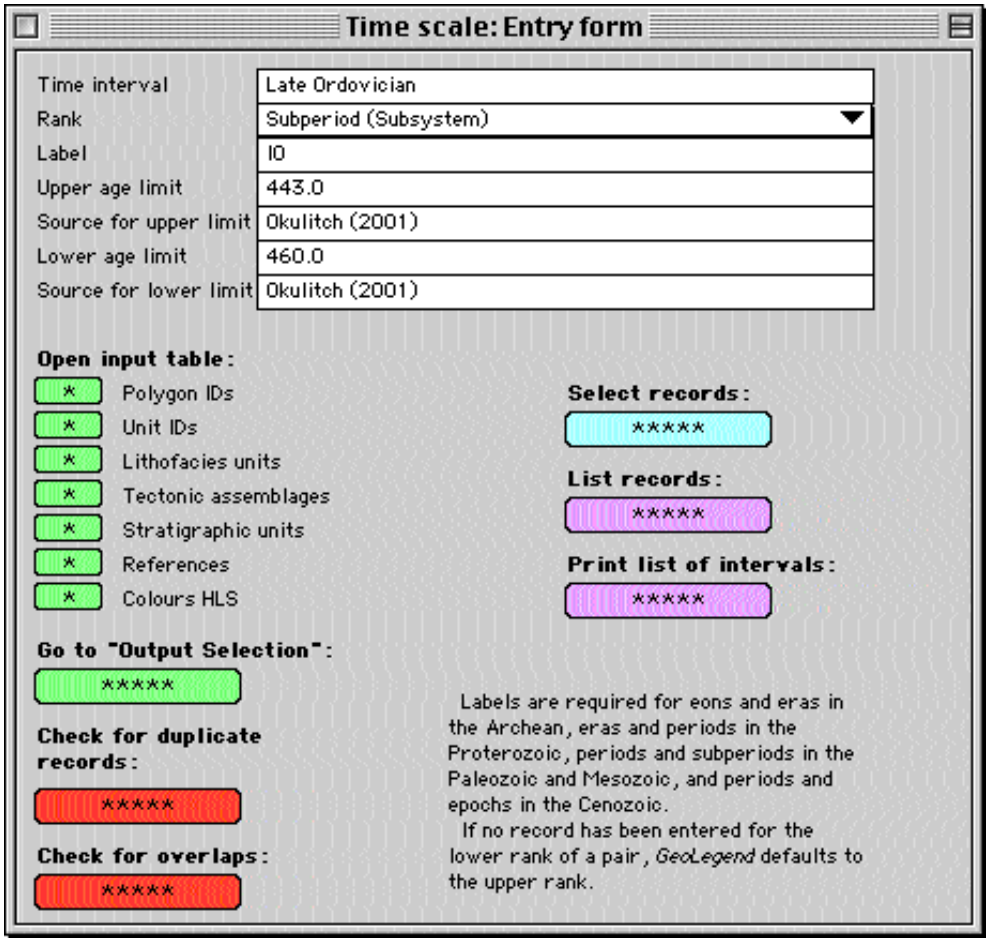

Figure 8. *'Time scale' table. Form used to enter data from geological time scales.*

Figure 8 is best viewed at 125% magnification

Entry Variables

Time interval:

The name of any time interval that is defined in the time scale, such as Phanerozoic, Ordovician, Llandovery or *D. clingani* (zone). It is unnecessary to include intervals that lie outside the age range of rocks in a region.

Alphanumeric.

The field must be filled.

All the names entered in this field are listed on the pop-up menus for the 'Stratigraphic age' fields in the 'Stratigraphic units' table. The variable links the 'Stratigraphic units' and 'Time scale' tables in a many-to-one relationship.

Rank:

The rank of the interval in the 'Time interval' field in terms of the hierarchy of geochronologic units in the stratigraphic code (North American Commission on Stratigraphic Nomenclature, 1983).

Alphanumeric.

The field must be filled.

Geochronologic units are used because *GeoLegend* is dealing with divisions of time defined in millions of years, rather than in bodies of rock.

"Subperiod" is used to denote the subdivisions of "Period" that commonly appear as legend headers for Paleozoic and Mesozoic rocks. These include specifically named subdivisions, like "Mississippian", and subdivisions preceded by "Early", "Middle" and "Late". The latter are commonly referred to as epochs but for the purposes of legends and unit labels need to be distinguished from specifically named epochs, such as "Arenig" or "Wenlock".

The "Other division" allows entry of sets of time intervals that do not fit the ranking scheme, or of classifications that are parallel to entries under one of other the rankings, e.g., Ordovician graptolite zones may be identified with the "Chron (Zone)" rank and Ordovician conodont zones with "Other division". Note that this does not preclude the entry of parallel classification schemes using the same ranking, as long as these are not "label records" (*see above*).

A record is identified uniquely in the 'Time scale' table by a combination of 'Time interval' and 'Rank'.

Label:

The character or characters used in the age component of map unit labels. This variable is accessed by the 'Stratigraphic units' table to build full unit labels.

Alphanumeric.

The field must be filled for all "label records". These are eons and eras in the Archean, eras and periods in the Proterozoic, periods and subperiods in the Paleozoic and Mesozoic, and periods and epochs in the Cenozoic.

If there is no time interval defined for the lower rank of a "label record" pair, *GeoLegend* defaults to the upper ranked interval. For example, "Neoproterozoic" is an era and is not subdivided at the period level into "Early", "Middle" and "Late", as is "Mesoproterozoic". Entries at the era level should be "Neoproterozoic" and "Mesoproterozoic". At the period level, "Early Mesoproterozoic" etc. are entered for the Mesoproterozoic time interval, but no entries are made for the Neoproterozoic interval. When *GeoLegend* needs an age label for Neoproterozoic time, it defaults to the label entered at the era level.

Upper/lower age limit:

The age limits of the 'Time interval' in millions of years.

Numeric. Values must be between "0" and "4600".

The fields must be filled.

The computed lower and upper age limits of units in the 'Stratigraphic units' table are compared with the ranges defined by these two fields in the 'Time scale' table so that the age component of a label and age titles in the legend can be determined (*see* 'Computed age' in the description of "Computed variables" under "Stratigraphic units").

"Label records" have special restrictions. For eons in the Archean, eras in the Proterozoic and periods in the Phanerozoic, the upper limit of a time interval should be the same value as the lower limit of the one immediately above it. Errors may cause *GeoLegend* to omit age labels and legend headers or choose the wrong ones. For eras in the Archean, periods in the

Proterozoic, subperiods in the Paleozoic and Mesozoic, and epochs in the Cenozoic, there should be no overlap of ages for succeeding intervals but gaps between intervals are permissible. For other records, overlaps and gaps are permitted. Overlaps are likely to occur when time coincident classifications are entered with the same ranking.

Source upper/lower age limit:

A reference or other note to indicate the source of the limits to the compiler of the database.

Alphanumeric.

The fields may be left empty.

Command Buttons

Open input table:

Clicking on one of these buttons opens the entry form for that table.

Go to "Output Selection":

Opens a form containing all the command buttons and menus required to generate a map, legend, and data and reference lists for a given area.

Check for duplicate records:

Checks the entire contents of the 'Time scale' table for records that have duplicate combinations of 'Time interval' and 'Rank'. Only one of a duplicate pair is shown and this is not necessarily the one containing the mistake.

Check for overlaps:

Checks the "label records" in the 'Time scale' table for succeeding time intervals that have overlapping values for the upper and lower time limits. Only one of an overlapping pair is shown and this is not necessarily the one containing the mistake.

Select records:

Opens a dialogue box so that the user can select records having particular values of variables in the 'Time scale' table.

List records:

Opens a window showing a list of records that meet the criteria defined in the 'Select records' dialogue box.

Double-clicking on a record opens the entry form with that record showing; it can then be edited.

Records can be exported to a text file by choosing 'Export All' from the 'File' menu, or by selecting records from the list and choosing 'Export Selections'.

Records can be deleted by choosing 'Delete All' from the 'View' menu, or by selecting records from the list and choosing 'Delete Selections'.

Print list of intervals:

Prints a list of time intervals in the 'Time scale' table that meet the criteria defined in the 'Select records' dialogue box. The time intervals are sorted by their lower age limits.

REFERENCES

Figure 9 shows the entry form for bibliographic information.

Entry Variables

GIS ID:

The number assigned to an individual geological source map for use in the graphical component of the GIS.

Alphanumeric.

The field may be left empty, but must be filled for references to maps that are used in the graphical component of the GIS.

Figure 9 is best viewed at 153% magnification

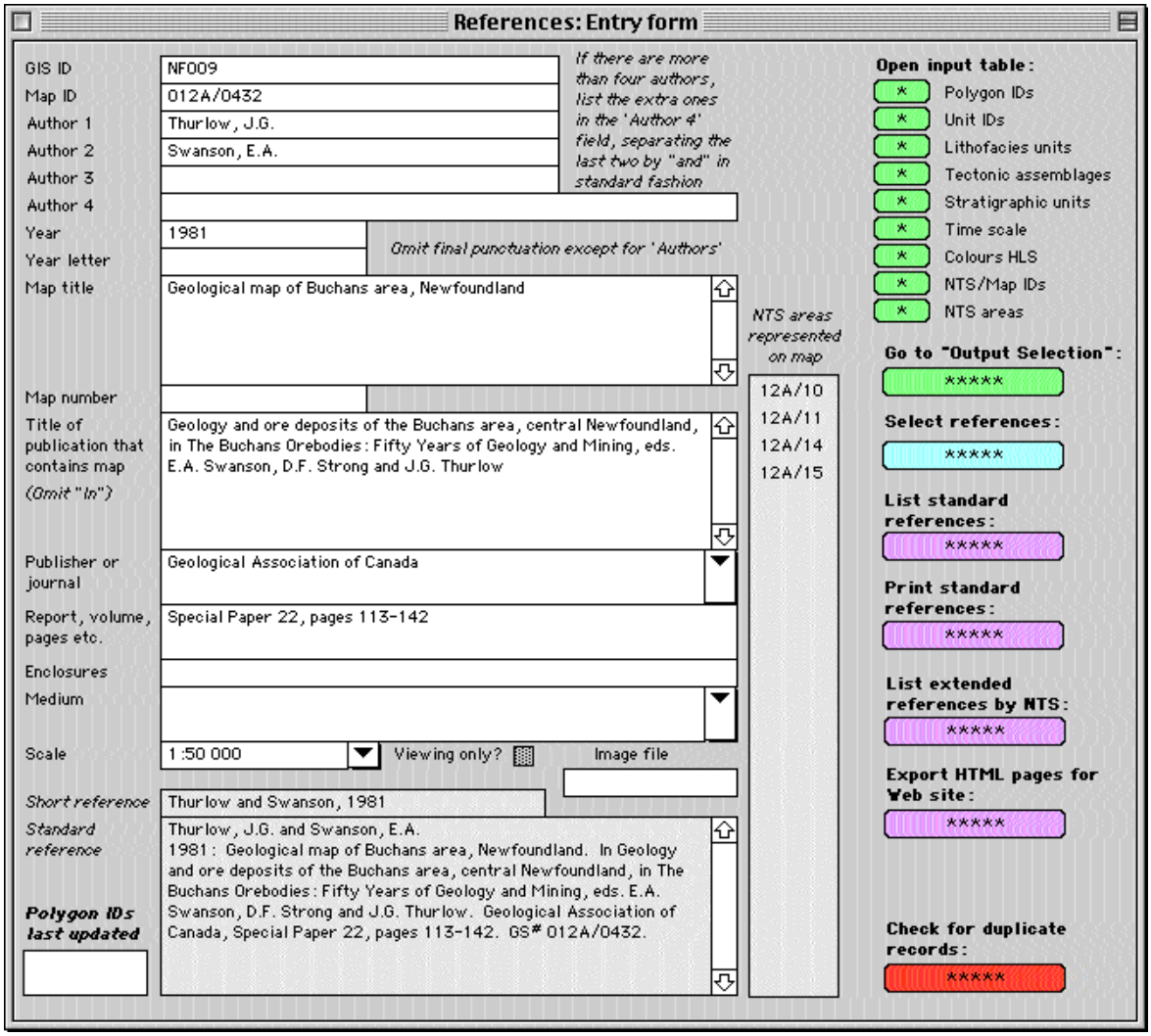

Figure 9. *'References' table. Form used to enter reference data.*

'GIS ID' can be of any length and can contain any characters, provided that the last three characters are numbers. These three numbers should be sufficient to identify the map in the region. The characters before these can be used to distinguish one region from another.

A record cannot be entered if the number in 'GIS ID' is the same as that previously entered for another record.

Map ID:

The catalogue number assigned to an individual geological source map.

Alphanumeric.

The field must be filled.

A record cannot be entered if the number in 'Map ID' is the same as that previously entered for another record.

If there is a bibliographic catalogue system for geological maps already in place in your region, the numbers in this system would probably be the best ones to use for 'Map ID'. In Canada, the GEOSCAN system fills this role and is recommended.

'Map ID' is printed at the end of each reference on the bibliographic listings produced from the 'References' table (*see* "Computed Variables", below) and is prefixed by "GS#", which stands for GEOSCAN or Geological Survey number.

If the chosen system does not have a number assigned to a particular map, some kind of temporary number must be assigned; placing this number in round brackets will cause bibliographic listings to show the "GS#" as "not assigned".

If the catalogue system has a single number assigned to a series of maps, each map should be identified separately by adding a suffix, e.g., "NFLD/0979a", "NFLD/0979b", etc. If a map occurs in a book, add the page number as a suffix, e.g., "NFLD/2345_116".

'Map ID' is also present as a variable in the 'Polygon IDs' and 'Unit IDs' tables. It links the 'References' table to these two tables in a one-to-many relationship.

Note that 'Map ID' is not normally the same as 'GIS ID', which is the map number in the polygon identifier in the graphical component of the GIS.

There is, however, a one-to-one relationship between the two numbers, and the 'References' table is used to convert one to the other as required by operations within *GeoLegend*. 'Map ID' is not used in the graphical component of the GIS because some GIS are unable to handle the long text strings used by GEOSCAN and similar cataloguing systems.

Author 1, 2, 3 and 4:

Four fields for entering the names of the authors of a map.

Alphanumeric.

Except for 'Author 1', the fields may be left empty.

Authors names should be entered with the surname first, followed by a comma and then the initials, e.g., "Colman-Sadd, S.P.". One author should be placed in each field. If there are more than four authors, the rest are entered as a text string in the 'Author 4' field, and the last two are separated by "and" in the standard fashion.

Listings show the authors on a separate line from the rest of the reference (i.e., they are followed by a carriage return).

Year:

The year of publication of the map.

Numeric.

The field is normally filled. However, if no year is available, the field may be left empty and text explaining why it is empty can be entered in 'Year letter', below.

GeoLegend will automatically end the 'Year' or 'Year letter' entries with a colon.

Year letter:

Text to be attached to the end of 'Year' or to replace 'Year' in the reference.

Alphanumeric.

The field is normally used if there is more than one reference by the same author in the same year, e.g., for "Dean, 1987a" and "Dean, 1987b", the "a"

and "b" are entered in this field. The field can also be used to enter text that replaces 'Year' in the reference, e.g., "Dean, *in press*".

Map title:

The title of a map

Alphanumeric.

The field may be left empty. Because *GeoLegend* is principally concerned with maps, each map within a publication should be given a separate record, rather than having one record for a publication that contains several maps.

The field is normally filled for any map that is used in the graphical component of the GIS. It will often be left empty for publications that are used as the sources of general information to compile legend descriptions.

Trailing punctuation should be omitted.

Map number:

The number assigned by a survey or other institution to identify the map within a series.

Alphanumeric.

The field may be left empty.

GeoLegend will automatically prefix the entry with "Map".

Title of publication that contains the map:

The title of a publication, such as a survey memoir, that contains the map.

Alphanumeric.

The field may be left empty.

If the 'Map title' field is also filled, *GeoLegend* will automatically prefix the entry with "In".

Trailing punctuation should be omitted.

Publisher or journal:

The publisher (survey or other institution) of a map or the name of a journal or book publisher.

Alphanumeric.

The field may be left empty.

Trailing punctuation should be omitted.

Values can be typed in, but when a value is present on one record, it appears on the pop-up menu and should thereafter be entered by selecting it from the menu.

Report, volume, pages etc.:

The number of a report or volume referred to in 'Title of publication that contains the map', and page numbers, if relevant.

Alphanumeric.

The field may be left empty.

Numbers should be prefixed by "Memoir", "Volume" etc. as appropriate.

Trailing punctuation should be omitted.

Enclosures:

Loose enclosures such as maps in the report or volume referred to in 'Title of publication that contains the map'.

Alphanumeric.

The field may be left empty.

There are no automatic prefixes to entries and the word "enclosure" should be typed in, if appropriate. Entries follow a comma after the 'Report, volume, pages etc.' field.

The field is not shown on the standard reference lists, but does appear on the extended reference lists produced by clicking the 'List extended references by NTS'.

Trailing punctuation should be omitted.

Medium:

The medium on which the map or publication is reproduced, e.g., microfiche, blueline paper, etc.

Alphanumeric.

The field may be left empty.

Values can be typed in, but when a value is present on one record, it appears on the pop-up menu and should thereafter be entered by selecting it from the menu.

The field is not shown on the standard reference lists, but does appear on the extended reference lists produced by clicking the 'List extended references by NTS'.

Trailing punctuation should be omitted.

Scale:

The scale of the map referred to in the 'Map title' field.

Alphanumeric.

The field may be left empty.

Entries are automatically prefixed by "Scale:".

Values can be typed in, but when a value is present on one record, it appears on the pop-up menu and should thereafter be entered by selecting it from the menu.

The field is not shown on the standard reference lists, but does appear on the extended reference lists produced by clicking the 'List extended references by NTS'.

Trailing punctuation should be omitted.

Viewing only?

A field to indicate whether a map or publication is available for sale or for viewing only.

Flag.

The field may be left undefined.

If the field is checked, an extended reference produced by clicking the 'List extended references by NTS' ends with "(viewing only)", implying that the publication is not available for sale. The field is not shown on the standard reference lists.

GeoLegend is designed principally for use by geological surveys. In the course of managing map units for a region, it can also serve double duty as a bibliographic database and can be used to produce map catalogues. The extended reference list is designed for this purpose, and hence whether a map is available for sale becomes relevant information.

Image file:

The name of an image file of the map used on a Web site (*see* "Creating a Map Index for the Web", below).

Alphanumeric.

The field may be left empty.

Polygon IDs last updated:

The date of last revision for records in the 'Polygon IDs' table for the map referred to in the 'GIS ID' and 'Map ID' fields.

Date.

The field may be left empty. The field is automatically updated when a record is entered or modified in the 'Polygon IDs' table.

As described in "Replacing Polygon IDs" in the description of the 'Polygon IDs' table, the records in this table commonly need to be revised *en bloc* for an entire map. This field allows the compiler to keep track of updates.

Computed Variables

Short reference:

This field shows the abbreviated version of the reference contained in the current record, e.g., "Dean, 1977a".

The 'Short reference' is used as the key linking the 'References' table to the 'Lithofacies units', 'Tectonic assemblages' and 'Stratigraphic units' tables in one-to-many relationships. All values of 'Short reference' in the 'References' table appear on the pop-up menus attached to the 'Description reference 1' and '2' fields in these tables. Entries can only be made into these fields from the pop-up menus and legend descriptions cannot be entered into these three tables unless at least one of the reference fields is filled. References must therefore be entered into the 'References' table first.

Standard reference:

This field shows the full version of the reference contained in the current record, as it would appear in the reference list of a Geological Survey of Newfoundland and Labrador publication. The reference does not include information in the last six entry fields ('Enclosures' onwards).

The computed field can be checked for correct punctuation etc., as a record is being entered, to make sure the proper format is being followed.

NTS areas represented on map:

Provided that information has been entered for National Topographic System (NTS) maps or equivalent (*see* "Command Buttons", below), this subform shows the NTS areas represented on the map referenced by the current record.

Command Buttons

Open input table:

Clicking on one of these buttons opens the entry form for that table.

Open input table: NTS/Map IDs:

Clicking the command button opens the entry form for the 'NTS/Map IDs' table. The table provides the link between the 'References' table and the 'NTS areas' table, and allows the references to be sorted by NTS area. If this type of sorting is not required the table need not be filled out.

There are two entry fields in the 'NTS/Map IDs' table, both of which are alphanumeric and both of which must be filled.

'NTS area' is the index number of the topographic map area. It should be filled from the pop-up menu, which contains all the areas entered into the 'NTS areas' table (*see* "Open input table: NTS areas", below). The 'NTS

areas' table should therefore be filled out before entries are made into the 'NTS/Map IDs' table. Values can be typed into the 'NTS area' field in the event that there are more areas than can be shown on the pop-up menu. 'NTS area' in the 'NTS/Map IDs' table has a many-to-one relationship to 'NTS area' in the 'NTS areas' table.

'Map ID' is the same as 'Map ID' in the 'References' table. It can only be filled from the pop-up menu, which contains all values of 'Map ID' in the latter table. 'Map ID' in the 'NTS/Map IDs' table has a many-to-one relationship to 'Map ID' in the 'References' table.

The computed variable, 'Extended reference', is shown beneath the entry fields.

Clicking on the button, 'Open NTS/Map IDs list', opens a list of all combinations of the two variables, sorted by NTS area. Any combination on the list can be double-clicked to show it on the entry form.

The suggested procedure for filling out the 'NTS/Map IDs' table is as follows. Fill in the first value of 'Map ID' from the pop-up menu. Fill in an 'NTS area' in which it occurs. Press the 'Enter' key to enter the record and move to a clear form for entry of the next record. The value for the previous 'Map ID' is retained on the new record unless changed and only the 'NTS area' needs to be filled in. When all the NTS areas for a particular 'Map ID' have been entered a new value of 'Map ID' can be selected.

The 'Print list' command button allows printing of a list of all combinations of 'Map ID' and 'NTS area'.

The 'Check errors' command button opens a list of records in which either the combination of 'Map ID' and 'NTS area' is not unique, or 'Map ID' is not represented in the 'References' table, or 'NTS area' is not represented in the 'NTS areas' table.

Open input table: NTS areas:

Clicking the command button opens the entry form for the 'NTS areas' table (Figure 10). The table is used to list all the NTS areas (or equivalent) in the region. If sorting of geological maps by area is not required, the 'NTS areas' table need not be filled out.

The entry variable, 'NTS area', is alphanumeric and links to 'NTS area' in the 'NTS/Map IDs' table.

All NTS areas stored in the table are listed below the entry field. Double-clicking on one of these brings it into the editing rectangle.

Figure 10 is best viewed at 143% magnification

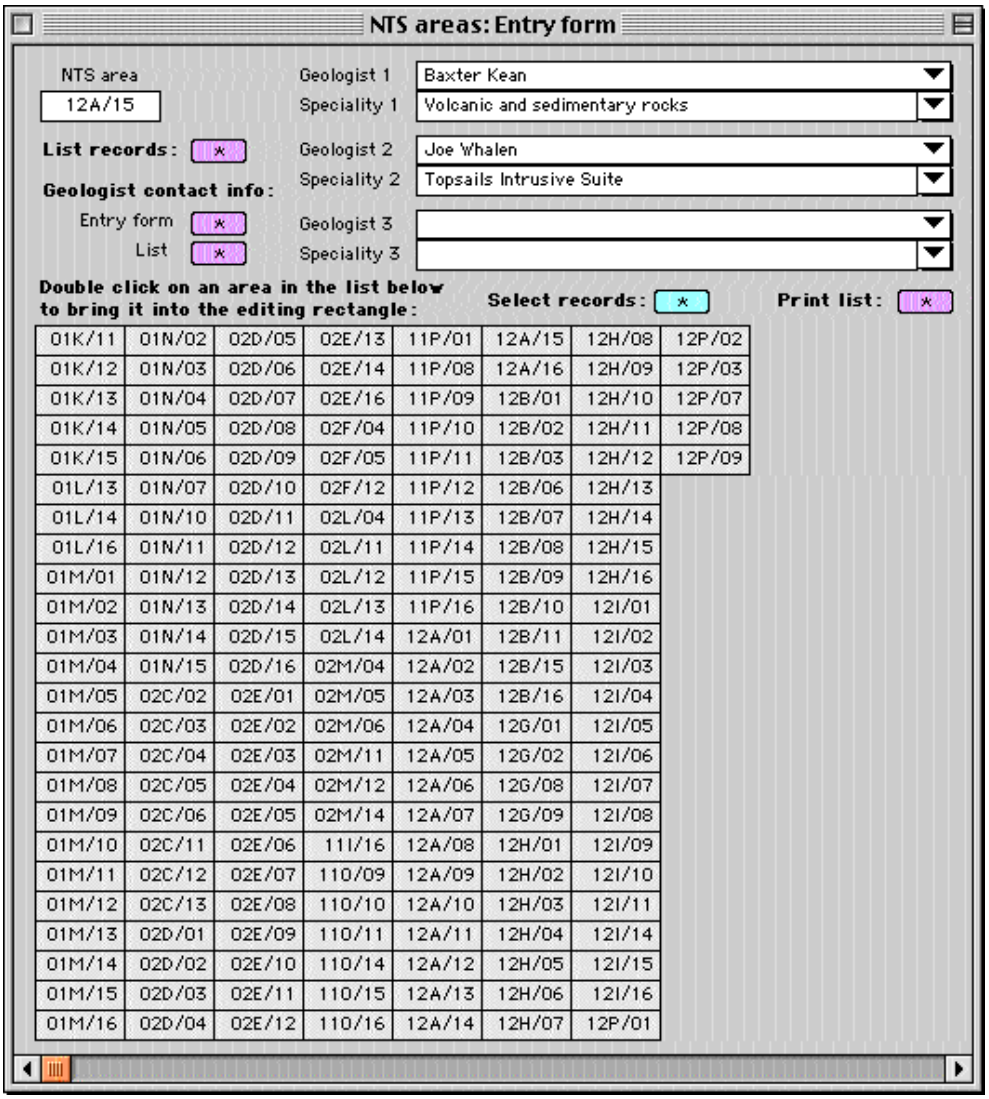

Figure 10. *'NTS areas' table. Form used to enter NTS areas and the names of geologists with expert knowledge of those areas. A command button is provided for editing geologist contact information, and a list of NTS areas already entered is shown in the lower part of the form.*

There are also six optional entry fields. These are intended for use by a geological survey where there is a need to assign responsibility for areas to particular personnel. Output from these fields is added to Web pages created by the command button, 'Export HTML pages for Web site' on the 'References: Entry form' (*see* "Creating a Map Index for the Web", below). Three of the optional fields allow entry of geologist's names and three allow a comment on that geologist's field of expertise. Geologist's names can only be entered from the pop-up menus. To add a name to the menus, click the 'Entry form' button under 'Geologist contact info' and fill in the name and as much contact information as is needed. One geologist can be designated as a "general contact" by checking the box on the form. The "general contact" is

added to the Web pages for all NTS areas, whereas other geologists are only added to pages for the areas designated on the entry form. Entries in the 'Speciality' fields can be typed in or taken off the menus.

The 'List records' button shows a list of NTS areas, geologists and specialities. The 'Print list' button allows a list of NTS areas to be printed. Both lists are subject to the criteria defined through the 'Select records' button.

Go to "Output Selection":

Opens a form containing all the command buttons and menus required to generate a map, legend, and data and reference lists for a given area.

Select references:

Opens a dialogue box so that the user can select records with particular values of variables in the 'References' table. Under most circumstances 'Select references' should include the statement "Author 1 ≠ various sources" (*see* "Various sources record", below).

List standard references:

Opens a window showing a list of references in standard format that meet the criteria defined in the 'Select references' dialogue box. References are sorted alphabetically by author and by year.

Double-clicking on a reference opens the entry form with that reference showing. It can then be edited.

Standard references can be exported to a text file by choosing 'Export All' from the 'File' menu, or by selecting references from the list and choosing 'Export Selections'.

References can be deleted by choosing 'Delete All' from the 'View' menu, or by selecting references from the list and choosing 'Delete Selections'.

Print standard references:

Prints a list of references, in standard format, that meet the criteria defined in the 'Select references' dialogue box.

List extended references by NTS:

Opens a window showing a list of references, in extended format. References are sorted by NTS area, and then alphabetically by author and by

year. References are only included if 'Map ID' has been entered in the 'NTS/Map IDs' table.

Double-clicking on a reference opens the entry form for the 'NTS/Map IDs' table with that reference showing.

Extended references can be exported to a text file by choosing 'Export All' from the 'File' menu, or by selecting references from the list and choosing 'Export Selections'. The exported text file can be automatically formatted in Microsoft Word™ by running the 'Format_refs' macro listed in Appendix 4.

Entries in the 'NTS/Map IDs' table can be deleted by choosing 'Delete All' from the 'View' menu, or by selecting references from the list and choosing 'Delete Selections'. Note that references can not deleted from the 'References' table using the extended references list.

Export HTML pages for Web site:

Clicking on the button opens a window for the entry of general information required for a Web site map index (Figure 11). In the first field enter the name of the region. This appears as a title on the Web page showing a full reference list for all NTS areas. Then select the 'Map ID' for the regional map (the same as is used for either the 'Lithofacies units' or 'Tectonic assemblages' table) from the pop-up menu. The complete reference for the map is shown in the computed field below and appears at the beginning of the full reference list. Then edit the HTML <BODY> statement for the Web pages that display the references lists. The default has the parameters used at the Geological Survey of Newfoundland and Labrador. If in doubt, simply use <BODY> in this field.

Figure 11 is best viewed at 154% magnification

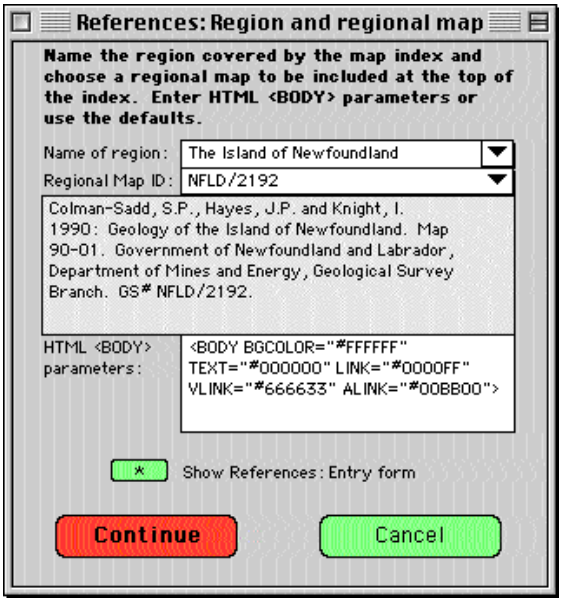

Figure 11. *Form used to choose a regional map for the Web map index and to edit HTML parameters on the index pages. The form is opened by clicking 'Export HTML pages for Web site' on the 'References' table entry form.*

Provided that the necessary setup procedures have been followed, press the 'Continue' button to generate Web pages for each NTS area and for a full reference list (*see* "Creating a Map Index for the Web", below).

Update Note

Check for duplicate records:

Checks the entire contents of the 'References' table for records that have duplicate combinations of the four author fields, 'Year' and 'Year letter'. Only one of a duplicate pair is shown and this is not necessarily the one containing the mistake.

Various Sources Record

Only two sources can be referenced in the 'Lithofacies units', 'Tectonic assemblages' and 'Stratigraphic units' tables for legend descriptions. If more than two sources have been used, the key phrase, "various sources", should be entered. This phrase can only be entered if it appears on the pop-up menus attached to the reference fields, and it can only appear on the menus if there is a record for it in the 'References' table. A record should therefore be created in the 'References' table in which "various sources" (not enclosed in quotes) is entered in the 'Author 1' field. So that this record does not appear on the various reference lists, the 'Select records' dialogue box should normally contain the statement, "Author 1 ≠ various sources". For this purpose, the phrase is permanently listed in the 'this item' column.

Creating a Map Index for the Web

The 'References' table can be used to generate an easily updatable, Web-based map index. The index map is divided up by NTS areas (Figure 12). When an NTS area is clicked, a window opens displaying the geological map references for that area and the names of individuals with expertise in its geology. A window can also be opened that shows the full listing of map references for the region, organized by NTS area. An image of the map can be attached to each reference.

The Web index has two parts: the page for the index map itself, and secondly the pages for the pop-up windows showing the reference information exported from *GeoLegend*.

Index map page:

This page shows a map of the region divided up into NTS areas. It does not need regular revision. An HTML image map is created for the region, assigning coordinates for each of the areas in the 'NTS areas' table and a link to a page named for each value of 'NTS area' in that table. Included in the

Figure 12 is best viewed at 194% magnification

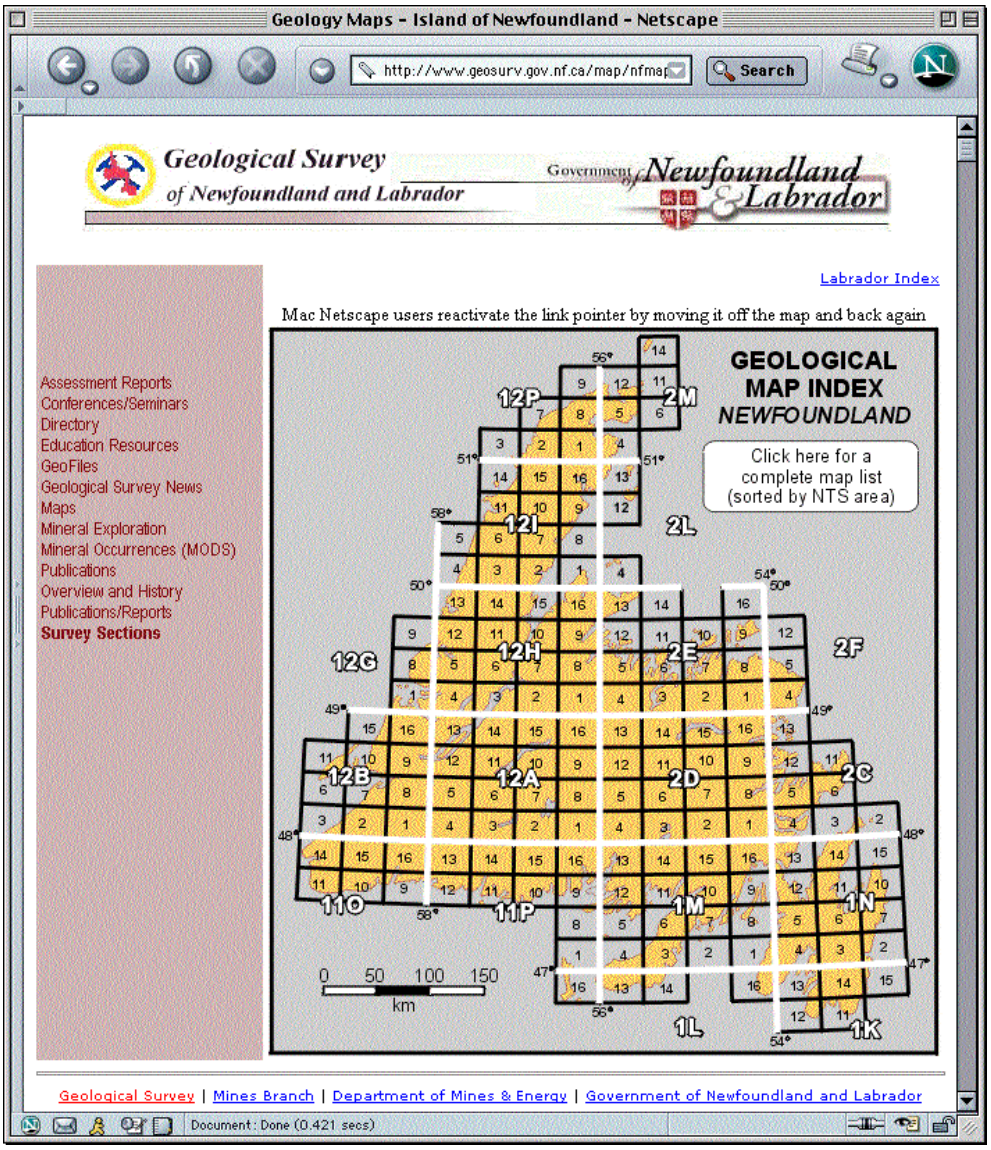

Figure 12. *NTS image map of the Island of Newfoundland. Each NTS area is linked to a Web page containing the references for that area. The pages are generated by clicking the button 'Export HTML pages for Web site' on the 'References' table entry form.*

image map is a clickable area linked to a page called "Full.html", which allows the full reference list to be opened. The image map can be created using a utility like Mapper 1.0; available for download from FTP archives, such as *http://hyperarchive.lcs.mit.edu/*.

Appendix 1a shows part of the HTML and JavaScript™ code for the index map page for the Island of Newfoundland. The JavaScript routines allow pop-up windows to open in two positions, on the opposite sides of the map from the areas that are clicked.

Reference pages:

The pages containing the actual references to geological maps are likely to need frequent revision. They are generated by *GeoLegend* when the 'Export HTML pages…' and 'Continue' buttons are clicked.

It is important to set up the export procedures correctly using the 'Set names and destinations of output files' form under the 'Setup' menu:

1. Create an empty folder (e.g., "Folder_B") inside another folder (e.g., "Folder_A") on your hard drive.

2. Create a text file in "Folder_B" called "00part_path". The file should contain a single line describing the path to "Folder_B" followed by the file name, "00part" (zero-zero-part): e.g., "Hard Drive:Folder_A: Folder_B:00part".

3. Set the destinations or sources of files by clicking the command buttons for the various files on the 'Set names…' form. Enter the correct file names and choose the correct folders in the dialogue boxes, as instructed on the form.

As well as containing the HTML files generated by *GeoLegend*, "Folder_B" should also contain a folder called "images". This folder contains the image file, if any, that appears at the top of each page. This file must be named "header.jpg". The "images" folder should also contain any map images that are attached to a reference and can be opened from that reference. The names of these files should be entered on the 'References: Entry form' in the 'Image file' field of the individual references that will link to them. *GeoLegend* automatically adds the link to the end of the reference.

When "Folder_B" is complete, it should be uploaded to the Web server and placed in the same directory as the index map page or the folder that contains it. In the example in Appendix 1, this directory contains "Folder_B" and a subdirectory called "Index_Map", which contains the actual index map "nfgeol.gif" and the page header, "headergs2.jpg". When revisions are required, add any new images to the "images" folder in "Folder_B" and click the 'Export HTML pages…' and 'Continue' buttons. These buttons update the text files in "Folder_B" on your hard drive with the current contents of the 'References' table. Then upload the revised "Folder_B" to the server and replace the earlier version.

Appendix 1b and 1c show sample HTML for the full and individual reference lists. The lists for individual areas also contain the names of geologists and their specialities, as designated in the 'NTS areas' table. The name of the geologist flagged as a "general contact" appears under the heading "For publications and general information" on the lists for all NTS areas.

COLOURS

Figure 13 shows one of the forms for entering colour information into the 'Colours' table. Colours in the table can be assigned to individual units in the 'Lithofacies units', 'Tectonic assemblages' and 'Stratigraphic units' tables using the 'Colour palette'.

Entry Variables

There are three forms for entering colour information, one each for the HLS, CMY(K) and RGB colour systems. Entry of values on any one of these forms automatically enters values for the same colour on the other two.

HLS:

HLS stands for hue, lightness and saturation.

All values are numeric integers and the fields must be filled. A record can not be entered if one already exists in the 'Colours' table with the same HLS values.

Figure 13 is best viewed at 131% magnification

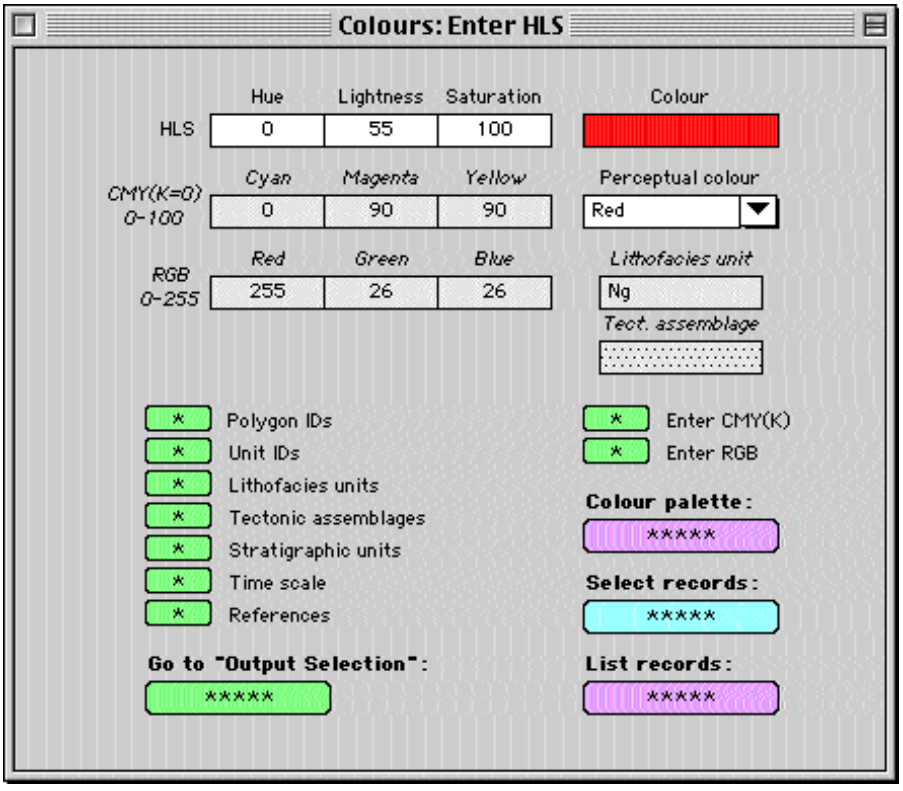

Figure 13. *'Colours' table. Form used to enter a colour in HLS format. Similar forms allow entry of colours in CMY(K) or RGB formats, if preferred.*

Hue values can be entered from 0 to 360, and lightness and saturation from 0 to 100.

Hue is described in terms of a 360° circle passing clockwise through the different wavelengths of light from red at 0°, through yellow, green, blue, violet, magenta and back to red. The 'Colour' table is initially set up with hues at 15° intervals, each showing ranges of lightness and saturation. Some intermediate hues have also been entered for colours used on the lithofacies map of the Island of Newfoundland.

Lightness varies from 0 (black) to 100 (white). Values have been entered at intervals of 10. Except for the grey scale (saturation of 0), no colours with lightness less than 30 have been entered because they are generally too dark for use on geological maps.

Saturation varies from 0 (grey scale) to 100 (maximum hue intensity). Values are entered at intervals of 20.

The HLS system is used for the 'Colour palette' and for colour entry in the 'Lithofacies units', 'Tectonic assemblages' and 'Stratigraphic units' tables. This is because HLS colour variations are more intuitive than in the other two systems, which are based on primary colours. Values are converted to the RGB system for output.

CMY(K):

CMYK stands for cyan, magenta, yellow and black. Cyan, magenta and yellow are the "subtractive" primary colours.

All values are numeric integers and the fields must be filled. There is no field for black (K), which is always assumed to be 0. A record can not be entered if one already exists in the 'Colours' table with the same HLS values.

Values vary from 0 to 100. If all three colours are 0, the colour is white, and if all three are 100, it is black.

Care must be taken that the CMYK system is not confused with the CMY system, in which there is no value for black.

RGB:

RGB stands for red, green and blue, which are the "additive" primary colours.

All values are numeric integers and the fields must be filled. A record can not be entered if one already exists in the 'Colours' table with the same HLS values.

Values vary from 0 to 255. If all three colours are 0, the colour is black, and if all three are 255, it is white.

The RGB system is recognized by almost all graphics and GIS packages and consequently *GeoLegend* uses this system for its output files.

Colour:

An image of the colour represented by the colour values in the numeric fields.

Picture data type.

A rectangle is created in a graphics program and filled with the colour corresponding to the values in the numeric colour fields. The rectangle should be 4 cm wide and 0.75 cm high. Copy it to the clipboard and then paste it into the field on the entry form.

Perceptual colour:

The "perceptual" primary colour represented by the colour values in the numeric fields.

Alphanumeric.

The field may be left empty.

Values can only be entered from the keyword list on the pop-up menu. For many transitional colours, the choice of 'Perceptual colour' is somewhat arbitrary and can be changed to accommodate individual preferences.

The numeric systems group colours by hue or primary colour. Geologists often want to choose from a range of "perceptual" primary colours, but some of these are scattered throughout the 'Colour palette' if it is sorted by numeric values. Brown, in particular, is a perceptual colour commonly used on geological maps but unrecognized under the numeric systems. Filling the 'Perceptual colour' field allows all browns to be grouped on the palette so that the selection of different shades can be more easily made for different units.

Computed Variables

Lithofacies unit:

The 'Lithofacies label' of a unit in the 'Lithofacies units' table for which a particular colour has been chosen. If the colour has been selected for more than one unit, only one is shown.

Tectonic assemblage:

The 'Tectonic assemblage label' of a unit in the 'Tectonic assemblages' table for which a particular colour has been chosen. If the colour has been selected for more than one unit, only one is shown.

Command Buttons

Open input table:

Clicking on one of these buttons opens the entry form for that table.

Go to "Output Selection":

Opens a form containing all the command buttons and menus required to generate a map, legend, and data and reference lists for a given area.

Enter HLS, CMY(K), RGB:

Opens the form for direct entry of values under the specified colour system. *GeoLegend* automatically enters values for all three systems, no matter which form is used.

Colour palette:

Opens a palette of all colours that have been entered showing the colour image and its HLS value.

The palette can be sorted in a variety of ways by selecting 'Sort Order…' under the 'Set' menu. The default (HLS-HSL) uses the HLS system and sorts on hue, saturation and lightness, in that order. Other methods use the numeric systems with the components in various orders, the perceptual colours with subsorting by the HLS system, and the lithofacies units with unit colours appearing at the top of the palette.

Colours are entered from the palette into the 'Lithofacies units', 'Tectonic assemblages' and 'Stratigraphic units' tables by double-clicking on a colour.

This opens a window called 'Colour value', which shows the HLS value of the colour selected and the colour image. Copy and paste the HLS value into the 'Assign colour' field.

Select records:

Opens a dialogue box so that the user can select records with particular values of the variables in the 'Colours' table. 'Select records' does not affect the contents of the 'Colour palette'.

Normally the 'Select records' box should contain the statement "Colour defined = Defined". This hides three records that have no colour information but instead provide prompts on the unit entry forms in the colour image fields.

List records:

Opens a window showing a list of records that meet the criteria defined in the 'Select records' dialogue box.

Double-clicking on a record opens the entry form with that record showing; it can then be edited.

Records can be exported to a text file by choosing 'Export All' from the 'File' menu, or by selecting records from the list and choosing 'Export Selections'. The colour images can not be exported.

Records can be deleted by choosing 'Delete All' from the 'View' menu, or by selecting records from the list and choosing 'Delete Selections'.

List records has the same set of sorting orders as the 'Colour palette'.

OUTPUT SELECTION

Figure 14 shows the 'Output Selection' form, which contains all the tools required to extract data from *GeoLegend* for the production of customized maps, legends and reference lists. The form is divided into five blocks:

1. Top left: Command buttons are used to define the area of the geological map being produced.

2. Centre left: Pop-up menus are used to customize the level of detail required for the various units on the map.

3. Bottom: Command buttons select the different kinds of output to be exported as text files and the formats of the legends.

Figure 14 is best viewed at 148% magnification

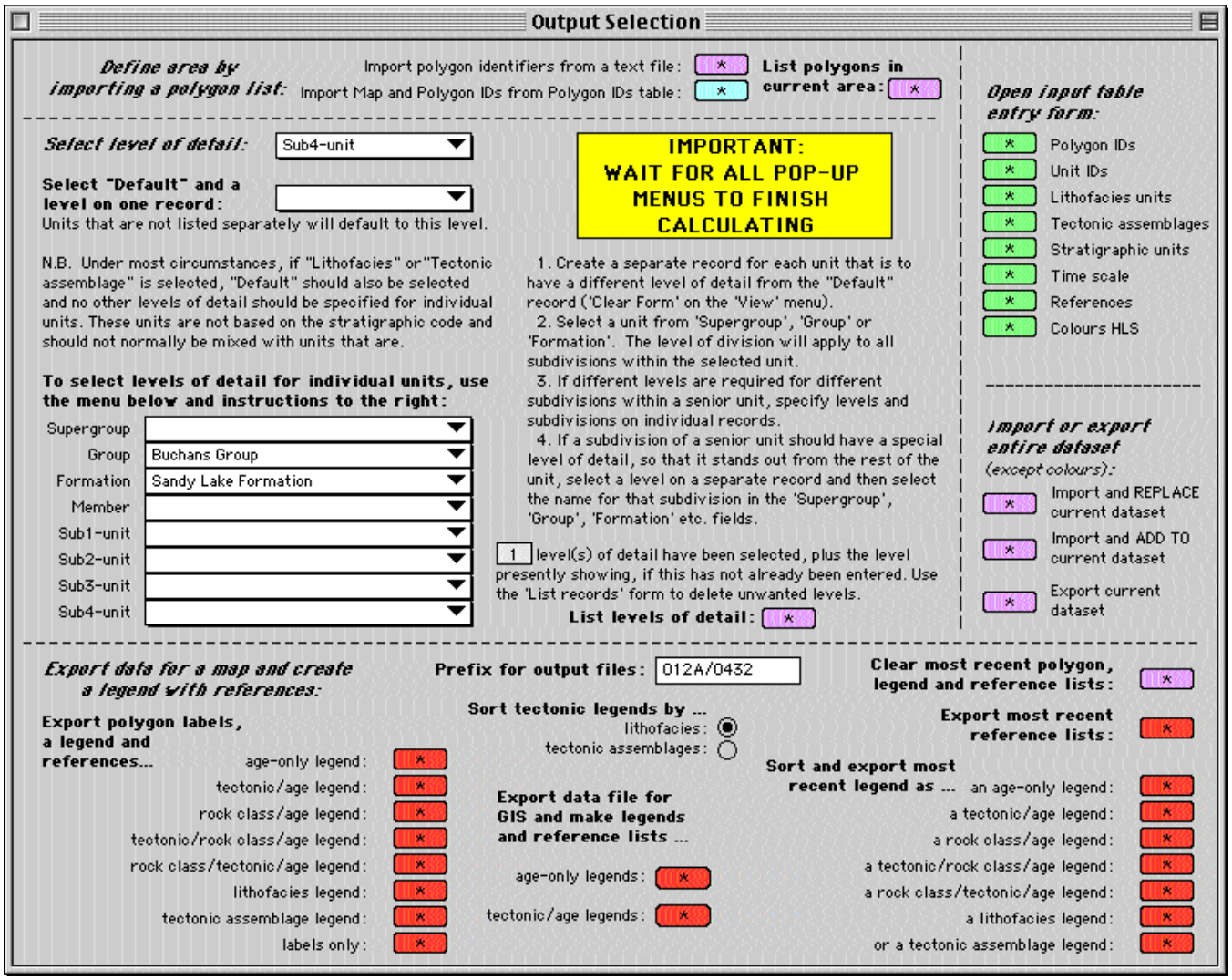

Figure 14. *'Output Selection' form used to retrieve data for the production of geological maps, legends, data files and reference lists.*

4. Top right: Command buttons provide easy access to the input tables in *GeoLegend*.

5. Centre right: Command buttons allow the exchange of data between different copies of *GeoLegend* and with other database packages.

Defining the Area of the Map

The area of the map is defined in one of two ways by clicking on the appropriate command button. Use these buttons to tell *GeoLegend* which polygons are to be included in the map and legend being produced. Once a set of polygon identifiers has been imported, it remains in storage until another set is imported. Therefore, if you want to produce several maps with different levels of detail for the same area, it is not necessary to repeat the importing procedure for each one.

Import polygon identifiers from a text file:

This method is used if the area is selected in the graphical component of the GIS. First define the area either by choosing a complete map file or by outlining and extracting part of a map. Then export a text file of all the polygon identifiers within the selected area. If only part of a larger map is selected, two situations require special care:

1. Polygons that are only partly included in the selected area and whose centroids are located outside the area may be omitted from the list of identifiers. It is important to make sure that they are included in the list, using whatever methods are available for your particular GIS.

2. Two or more pieces of a single polygon may occur on the extracted file of an outlined area, producing multiple polygons with the same supposedly unique identifier. These may be flagged as errors by the GIS. They are not errors, and the polygons must be retained with their original identifiers. *GeoLegend* automatically deletes any duplicate identifiers when it imports the text file. On its output list, there will be one record for each identifier and this record will, under these circumstances, apply to more than one polygon.

   Part of a typical text file for importing into *GeoLegend* may look like this:

```
NF003_0156¶
NF003_0157¶
NF003_0158¶
NF003_0158¶
NF003_0159¶
NF014_0034¶
NF014_0067¶
NF014_0157¶
```

The format for polygon identifiers is described at the beginning of the section on the 'Graphical component of the GIS'. The front part of the identifier (NF003) identifies the original source map; in this example, pieces of two source maps are included within the selected area. The end part of the identifier (0156) is the number of the polygon within a particular source map. Polygon identifiers must be separated by single carriage returns on the text file. If the file was produced under the Windows™ operating system, surplus line feeds must be removed.

When the text file has been prepared, it is imported into *GeoLegend* by clicking the command button, 'Import polygon identifiers from a text file'. This button first deletes any set of identifiers held in storage from a previous importing command. Then it opens a dialogue box in which you identify the correct text file and click "Import Text". All the "Options…" are preset to their default values and should not need adjusting. They assume the file does not include a field header. If it does, either remove the header or check the "Include field headers" box.

Once imported, the identifiers are converted into their equivalent 'Map ID' and 'Polygon ID' values (*see* "Polygon IDs"). Duplicate records produced by fragmented polygons are deleted (*see above*). So too are records that have no match in the 'Polygon IDs' table. Unless there have been errors in compiling the dataset, these records represent polygons that will be left blank on the map such as lakes, ocean, or areas outside the limit of geological mapping.

GeoLegend is now ready for the levels of detail to be selected (*see below*).

Import Map and Polygon IDs from Polygon IDs table:

Update Note

This method can be used if it is already known which polygons are to be shown on a map and they can be easily identified by a search statement. Usually this is the case if the map to be produced is derived from one or more complete source maps. The method is also useful for generating test legends to check that the data in the input tables are producing the desired output.

The command button first deletes any set of identifiers held in storage from a previous importing command and then opens a dialogue box similar to that opened by the 'Select records' button in the 'Polygon IDs' table. Usually one or more values of 'Map ID' will be selected. Then close the dialogue box and choose 'Click to continue' to make a subset of the polygons defined by the selection criteria, or choose 'Cancel'.

GeoLegend is now ready for the levels of detail to be selected (*see below*).

List polygons in current area:

Opens a window showing a list of the polygons currently stored for output, sorted by 'Map ID', 'Polygon ID' and 'Priority' (*see* description of "Entry Variables" in "Polygon IDs"). The list also shows values of 'Lithofacies label', 'Tectonic assemblage label' and the eight unit name fields from the 'Unit IDs' table, keyed to individual polygons.

Individual polygons can be deleted from the output list by selecting them and choosing 'Delete Selections' from the 'View' menu.

Selecting the Level of Detail

When the area of the map has been defined, the level of detail can be selected. One level of detail can be selected for all the units on the map or different levels can be selected for different units. A new record is required in 'Output Selection' for each level chosen.

Defaulting to the Available Level of Detail

The actual level of detail available for a unit may not correspond exactly to the level of detail chosen. For example, the area may include a formation that has never been subdivided below the formation level and "Sub4-unit" may be selected as the level of detail on the 'Output Selection' form.

Units that are not defined at the specified level of detail, default to the next higher level. If they are not defined at a higher level, they default to the next lower level. For example, if the level of detail is set at "Group":

1. Formations that are direct subdivisions of a supergroup and do not belong to a group, default to the 'Supergroup' level, and the supergroup is shown undivided.

2. Formations that do not belong to a group or supergroup are shown as separate formations.

3. Unnamed units that have a "dummy" formation name in round brackets and an entry in the 'Sub1-unit' field are shown as separate sub1-units.

Choosing the Default Level of Detail for a Stratigraphic Map

First ensure that there are no unwanted levels of detail already specified. The number of records presently existing in 'Output Selection' is shown by the number near the middle of the form. Click 'List levels of detail' to display

all current levels, select any that are not required, and choose 'Delete Selections' from the 'View' menu to delete these levels.

Decide on the level of detail required for all or most of the units on your map and choose this as the default value. This is done by entering the level from the pop-up menu in the 'Select level…' field and entering "Default" from the pop-up menu in the 'Select "Default"…' field.

There should be no entries for units in the eight unit name fields on the default record. When "Default" is showing in the 'Select "Default"…' field, no units are listed on the pop-up menus in the unit name fields and so no entries can be made in these fields.

If all units are to have the same level of detail, that showing in the 'Select level…' field, you are now ready to produce the unit labels and legend for a map. If some units are to have a different level of detail, they need to be specified on separate records.

Choosing Levels of Detail for Specific Units

Create a new record by selecting 'Clear Form' from the 'View' menu. Enter the desired level of detail in the 'Select level…' field and leave the 'Select "Default"…' field empty.

The pop-up menus in the eight unit name fields contain the units at the tops of all the stratigraphic hierarchies represented in the defined area (*see* "Defining the area of the map", above). No subsidiary units are shown until one of these senior units has been entered. If you enter one of the senior units, e.g., "Buchans Group", the pop-up menus below the group level now show only units that are direct subdivisions of the Buchans Group and are represented in the defined area. If you now choose one of these, e.g., "Sandy Lake Formation", and enter it into the formation field, the pop-up menus below the formation level now show only those units that are direct subdivisions of the Sandy Lake Formation. And so on down the stratigraphic hierarchy. When the selection is complete, press the 'Enter' key (or select 'Static Enter' from the 'View' menu) to enter the new record.

It is not necessary to specify the level of detail for every unit in a hierarchy. If you want the Buchans Group to be split into undivided formations, this can be achieved by one record that shows "Formation" in the 'Select level…' field and "Buchans Group" in the 'Group' field. All subdivisions of the Buchans Group will then be shown as undivided formations except those that are not defined at the formation level. These will default up the hierarchy and be shown simply as "Buchans Group".

If you then want to split out a specific horizon of felsic volcanic breccia within the Buchans Group, you create a record that has "Sub3-unit" entered in the 'Select level…' field and choose the various names and characters that define this unit, "Buchans Group" "Sandy Lake Formation" "v" "f" "x", as entries in the 'Group' to 'Sub3-unit' fields. This record overrides the record specifying the formation level and shows this particular horizon against a background of undivided Sandy Lake Formation.

Lithofacies and Tectonic Assemblage Maps

When a lithofacies or tectonic assemblage map is required, 'Lithofacies' or 'Tectonic assemblage' can be entered in the 'Select level…' field. Under most circumstances, these classifications should not be mixed together or with the stratigraphic classification on the same map because they have incompatible sorting and labelling criteria. Therefore, there should only be one record, which has "Default" entered in the 'Select "Default"…' field and no units selected in the unit name fields. Output is generated by clicking either the lithofacies or the tectonic assemblage command button (*see* "Data Output", below).

There may be occasions when it is desirable to mix the lithofacies, tectonic assemblage and/or stratigraphic classifications. Although all polygons will be assigned to their correct unit and the correct descriptions will appear on the legend, two problems should be guarded against:

1. Some polygon labels may be the same for different units. No checks are in place to make sure that labels in the 'Lithofacies units' or 'Tectonic assemblages' tables do not also occur as labels for stratigraphic units in the 'Stratigraphic units' table. As well as being confusing on the legend, this may result in unlike polygons being merged on the map.

2. Legends for lithofacies, tectonic assemblage and stratigraphic maps use different criteria for sorting units. Some of the units will, therefore, have to be sorted by cutting and pasting in the exported text file, and headers may have to be edited.

Data Output

A number of options are presented for data output. Each one is selected by clicking a command button and results in the exporting of polygon, legend and/or reference files.

Prefix for output files

The prefix is used to distinguish sets of files produced by GeoLegend from separate output runs. Optional AppleScript™ routines can be used to

process the output files and these add the prefix to the fronts of file names so they will not overwrite each other (*see* "Automated Management of Output Files", below). The prefix is alphanumeric and is optional if the AppleScript™ routines are not used. The prefix must not be more than 12 characters long and preferably should be shorter. For maps derived from individual source maps, the 'GIS ID' (5 characters) is recommended.

Sort tectonic legends by …

Tectonic legends are sorted by the tectonic divisions and subdivisions defined in the table for either 'Lithofacies units' or 'Tectonic assemblages'. Click one of the buttons to choose the classification to be used. The default is "lithofacies".

Activating the Command Buttons

Most of the command buttons in the output section expect that a new prefix has been entered and that the "Enter" key has not been pressed subsequently. Therefore, the first action they take is to "Enter" the changes. If no changes have been made or the "Enter" key has already been pressed, this action is redundant and the buttons are deactivated.

The easiest way to activate the command buttons is to make a change in the 'Prefix for output files'. Simply type in a new entry or, if you want the field to be empty, type a character and delete it. Do not press the "Enter" key. The command buttons are now activated and will enter the "change" for you.

Polygon Files

Three polygon files are exported when one of the command buttons in the left column is clicked ('Export polygon labels…').

Full polygon labels:

A text file, in Windows™ format, containing full polygon labels.

The file has commas as field delimiters, carriage returns and line feeds at the ends of records, and text fields are enclosed in "double quotes". It contains two variables:

1. The polygon identifier, as used in the graphical component of the GIS, e.g., "NF067_0045". This is the key that links the file to the polygons on the map in a one-to-many relationship.

2. The full label for the polygon, including subsidiary units and added characters. If the label refers to more than one unit, the units are separated by a slash (/).

All labels are adjusted for the levels of detail to be shown on the map. The file should be imported into the graphical component of the GIS and used to label the polygons on the map.

The name for the file should be set as "full" on the 'Set names and destinations of output files' form under the 'Setup' menu. If the AppleScript™ Legend Routine is used, the name is changed to "*prefix*lab.txt" before it is placed in the "Output archive_A" folder.

Dominant polygon labels:

A text file, in Windows™ format, containing the dominant label for each polygon.

The file has tabs as field delimiters, and carriage returns and line feeds at the ends of records. It contains two variables:

1. The polygon identifier, as in the file containing full polygon labels.

2. The dominant unit label for the polygon. Any subsidiary unit labels or added characters that appear in the full label are omitted from the dominant label.

Under some circumstances, the dominant label is useful as a key to distinguish polygons that should be coloured differently.

The name for the file should be set as "dominant" on the 'Set names and destinations of output files' form under the 'Setup' menu. If the AppleScript™ Legend Routine is used, the name is changed to "*prefix*key.txt" before it is placed in the "Output archive_A" folder.

Comparison of full and dominant labels:

Full and dominant labels for a set of polygons might be as follows:

Polygon identifier	Dominant label	Full label
NF008_0033	O:Wp	O:Wp
NF008_0034	O:Wp	O:Wp
NF008_0036	O:Wp	O:Wp?
NF008_0037	O:Wp	O:Wp/O:d
NF008_0045	O:Wp	O:Wp?/O:d

The full label contains additional information and should be the label that actually appears in the polygon on the final map.

If the map is being generalized, the full label should be used to determine which contacts are to be eliminated. In the above example, any contacts between polygons "NF008_0033" and "NF008_0034" are redundant and should be removed, but contacts between these two polygons and "NF008_0036" indicate the limits of certainty about the assignment to unit "O:Wp" and should be retained.

The dominant label is used to determine the colours of polygons. Whatever colour is assigned to unit "O:Wp", in the above example, is used for all five polygons.

For most polygons, the full and dominant labels are the same. This is true for polygons that contain no subsidiary units, and therefore have only one record in the 'Polygon IDs' table, and have no entry in the 'Added characters field'. It is also true for polygons that have more than one record in the 'Polygon IDs' table, but for which the labels at the requested level of detail are the same. For example, at the 'Sub1-unit' level a polygon might have a dominant label of "O:Wp" and a full label of "O:Wp/O:Wg"; at the 'Group' level the dominant label is truncated to "O:W" and the full label also reduces to "O:W".

Case-sensitive labels:

GeoLegend is case-sensitive and some labels may be distinguished on case only. If the graphical component of the GIS is not fully case-sensitive, contacts may be eliminated by mistake. Care must be taken to ensure that labels are distinguished as intended, if necessary by adding suffixes to otherwise ambiguous labels.

Polygon colours:

A text file, in Windows™ format, containing the RGB colour values for each polygon.

The file has tabs as field delimiters, and carriage returns and line feeds at the ends of records. It contains five variables:

1. The polygon identifier.

2. The dominant label for the polygon.

3. Colour values for each of red, green and blue.

The name for the file should be set as "colours" on the 'Set names and destinations of output files' form under the 'Setup' menu. If the AppleScript™ Legend Routine is used, the name is changed to "*prefix*col-rgb.txt" before it is placed in the "Output archive_A" folder.

Legend Files

A legend file is exported when one of the command buttons in the left column is clicked ('Export polygon labels…'). The file is initially in Macintosh™ text format but can be converted to a Microsoft Word™ file by running the "Legendscript" macro (Appendix 3). This is done automatically if the AppleScript™ Legend Routine is used.

Lithofacies and tectonic assemblage legends:

If 'Lithofacies' or 'Tectonic assemblage' was chosen in the 'Select level…' field, the legend should be produced by clicking the button for either 'Lithofacies legend' or 'Tectonic assemblage legend'. The legend will be formatted using the headers and sorting order entered into the 'Lithofacies units' or 'Tectonic assemblages' tables.

Stratigraphic legends:

If a stratigraphic level was chosen in the 'Select level…' field, various buttons allow different criteria for sorting the units. All stratigraphic legends are sorted by age, but they may also be sorted using tectonic division or rock class.

Sorting by tectonic division:

First, decide whether sorting should use the divisions in the 'Lithofacies units' table or in the 'Tectonic assemblages' table, and check the appropriate button.

Sorting by tectonic division can only be done if values have been entered in the 'Lithofacies label' or 'Tectonic assemblage label' fields in the 'Unit IDs' table, and if categories for "Tectonic division" and/or "Tectonic subdivision" have been used in either the 'Lithofacies units' or 'Tectonic assemblages' tables (*see* "Reorder or edit lithofacies categories" under "Lithofacies Units"). A stratigraphic unit is assigned to a tectonic division by way of its corresponding lithofacies or tectonic assemblage label, and tectonic divisions are sorted in the order specified in either the 'Lithofacies units' or 'Tectonic assemblages' tables (*see* "Ordering numbers for tectonic divisions/subdivisions" under "Lithofacies Units").

A stratigraphic unit at its maximum level of detail can only correspond to one lithofacies unit and one tectonic assemblage, and can therefore only belong to one tectonic division in each classification. However, a generalized unit may belong partly to one division and partly to another if its subdivisions equate with different lithofacies units or tectonic assemblages. In a tectonically sorted legend, such a unit is listed under each tectonic division to which it belongs, but within each division is correctly placed with respect to age and rock class. It is identified by a header that lists two tectonic divisions. This presentation is rarely satisfactory for a final product and each file should be edited to best suit individual circumstances.

Sorting by rock class:

Rock class legends divide units into two categories, "Lithostratigraphic units" and "Lithodemic units", depending on the entries in the 'Rock class' field in the 'Stratigraphic units' table. The lithodemic category includes units designated as "Intrusive", "Complex" and "Other lithodemic".

Resorting legends:

A legend is stored until it is replaced by a new legend or deleted by clicking the 'Clear most recent…' button. While it is stored, the legend can be exported as a text file using any of the available sorting criteria by clicking one of the 'Sort and export most recent legend as…' buttons.

Formatting exported legends:

An exported legend file is intended to be formatted in a word processor. Therefore, it is structured differently from other files exported from *GeoLegend* (i.e., it is in tab-delimited, Macintosh™ format). There are three options for doing the final formatting:

1. Setup the AppleScript™ Legend Routine and Microsoft Word™ macros to automatically format the legend and reference lists, and rename and archive all the exported files (*see* "Automated Management of Output Files", below).

2. Open the legend in Microsoft Word™ and run the "Legendscript" macro to format it without involving any of the other exported files. This is the procedure to follow, if the legend has been exported on its own, using one of the 'Sort and export most recent…' buttons, but can be applied to any unformatted legend.

3. Format the legend by hand in any word processor using the following sequence of global changes:

i) Select the entire text and change to point size 10 in the font of your choice.

ii) In Microsoft Word™ or similar software choose 'Autoformat' from the 'Format' menu twice. Alternatively, perform a global change of all text enclosed between two asterisks (**text**) to bold formatting, and then all text enclosed between two underscores (_*text*_) to italics. Then remove the asterisks and underscores with global changes.

iii) Replace two tabs by one tab. Repeat until no more changes are made.

iv) Replace carriage return-tab by one carriage return (do not include the hyphen).

v) Replace two carriage returns by one carriage return. Repeat until no more changes are made.

vi) Replace one carriage return by two carriage returns.

vii) Replace one tab by one carriage return.

viii) Replace %-carriage return by one tab.

ix) Change the formatting of all text enclosed by Ω (option-z) (Ω*text*Ω) to point size 12.

Certain special characters may not be visible in the full version of Adobe Acrobat. They are visible in Acrobat Reader 4.0 and above.

x) Change the formatting of all text enclosed by Δ (option-j) (Δ*text*Δ) to point size 14.

xi) Globally delete Ω and Δ.

xii) Set a hanging indent for the whole document, with an indentation sufficient to accommodate the longest unit label.

Legends are organized so that the age ranges of stratigraphic hierarchies and the names of supergroups, groups and formations appear as headers, as do the names of tectonic divisions and rock classes, when applicable. If a unit has more specific age information than its stratigraphic hierarchy, its specific age range is placed at the beginning of its legend description. Member names are also placed at the beginning of legend descriptions.

Reference Lists

Whenever a command button is clicked to produce a legend in the 'Export polygon labels…' column, two accompanying reference lists are also produced as separate text files. The first of these lists all source maps from which the polygons in the area have been digitized. The second lists any references to legend descriptions that do not already appear in the source map list. The AppleScript™ Legend Routine automatically appends the formatted lists to the end of the legend. Alternatively, they can be formatted by running the macros, "Mapref" and "Legref", for the map references and legend references respectively, or they can be formatted using a series of global changes. The formatting required is usually minor and intuitive.

Reference lists are not produced automatically by clicking one of the 'Sort and export most recent…' buttons. However, reference lists are retained until deleted or replaced, and the lists that accompany a legend in storage can be retrieved by clicking the command button, 'Export most recent reference lists'.

Exporting GIS Datasets

Export data file for GIS…:

Two command buttons are provided for producing a series of nine text files that package the primary information in *GeoLegend* for a selected area. These files can then be imported into any GIS, independent of operating system.

The files are:

1. A data listing containing fifty-six variables. The list is tab-delimited and has carriage returns and line feeds at the ends of records. Records are keyed to individual polygons by the polygon identifier and include unit names, labels, ages and summary rock types at various levels of detail, and source map references. A detailed description of variables is given in Appendix 5. When used as a flat data file in a GIS, the data list allows maps to be searched, generalized and customized interactively.

2. A stratigraphic legend, in which units are shown at their most generalized level, equivalent to a legend that would be produced if 'Supergroup' were selected in the 'Select level…' field.

3. A stratigraphic legend, in which units are shown at the level actually shown in the 'Select level…' field when the button is clicked.

Normally 'Sub4-unit' would be selected to give the maximum level of detail.

4. A lithofacies legend, such as would be produced if 'Lithofacies' was selected in the 'Select level…' field.

5. A tectonic assemblage legend, such as would be produced if 'Tectonic assemblage' was selected in the 'Select level…' field.

6. A list of references to sources of linework and legend descriptions.

7. A list of the keywords available on the menus in the 'Summary rock type' fields. The list gives an overview of the keywords and makes it easier to search for particular rock types.

8. The time scale used to calculate ages in the data list and legends. The list of numeric ages for the various intervals makes it easier to search by age.

9. A file containing the 'Prefix for output files'.

If the '… age only legends' button is clicked the two stratigraphic legends are sorted purely on the basis of age. If the '… tectonic/age legends' button is clicked the two legends are also sorted by tectonic division. Legends require the same formatting as is described in "Legends", above. The various legends and files can be formatted automatically by using the AppleScript™ GIS Routine and associated macros (*see* "Automated Management of Output Files", below).

Clearing Temporary Storage Tables

Clear most recent polygon, legend and reference lists:

When output is generated from *GeoLegend*, temporary tables are created to store the output files. If the output is for a large area, these tables can occupy a significant amount of disk space and may slow some operations. Clicking on this command button opens a dialogue box that allows you to delete the contents of these temporary tables by clicking the 'Clear lists' button. Clicking 'Cancel' returns you to 'Output Selection'.

If the disk space occupied by *GeoLegend* has been expanded to accommodate a particularly large set of temporary files, this space may not be recovered immediately, but all or part of it will be used for later temporary files. To recover disk space, run *GeoLegend* through the Helix Utility™ (if you own the full version of Helix RADE™) with 'Compression Available'

ticked on the 'File' menu. Then choose 'Compress Files' from the 'Tools' menu. Make a back-up before doing this.

Automated Management of Output Files

The automated formatting and management of output files requires that you have Microsoft Word 98™ (or later) installed on your hard drive. AppleScript™ and the Script Editor™ are included with the Macintosh™ operating system. The AppleScript™ routines are intended for use with Mac OS 9.2 or earlier.

AppleScript Legend Routine:

Create two new folders, "Output folder_A" and "Output archive_A".

The legend routine is reproduced in Appendix 2a. Open the Script Editor™ and type or paste the routine into a new window. Amend the paths to "Output folder_A" and Output archive_A" to match your computer setup by substituting the name of your hard drive and adding extra folders, if necessary. Save the routine as a compiled script. You can place it in the same folder as "Output folder_A" or else in the "Folder action scripts" folder in the System's "Scripts" folder.

Select "Output folder_A", press the "Control" key and the mouse button. A menu opens. Select "Attach a Folder Action…" and choose the legend routine. The folder icon should now show an attached script image. The folder must be left open to trigger the AppleScript™ routine.

The routine is triggered when *GeoLegend* exports seven files into the folder, which is the number produced by clicking one of the 'Export polygon labels…' buttons. The routine then opens Microsoft Word™, uses the Word macros to format the legend and append the references, renames the resulting files with the output file prefix added to the start of each file name, and moves the four resulting files to the "Output archive_A" folder. These files contain the legend and appended references (*prefix* Legend), the full labels (*prefix*lab.txt), the dominant labels (*prefix*key.txt) and the polygon colours (*prefix*colrgb.txt).

If you do not want the routine triggered automatically, close "Output folder_A". The files will then be deposited in the folder with the names given to them by *GeoLegend*. You can process them later by opening the Script Editor™ and manually running a duplicate of the legend routine with the first 5 lines and the last 2 lines deleted.

AppleScript GIS Routine:

Create two new folders, "Output folder_B" and "Output archive_B".

The GIS routine is reproduced in Appendix 2b. Open the Script Editor™ and type or paste the routine into a new window. Amend the paths to "Output folder_B" and "Output archive_B" to match your computer setup by substituting the name of your hard drive and adding extra folders, if necessary. Save the routine as a compiled script.

Attach the GIS routine to "Output folder_B" using the Control key and mouse button, as described above for the legend routine. Provided the folder has been left open, the routine is triggered when *GeoLegend* exports the nine files produced by clicking one of the 'Export data file for GIS…' buttons. The routine then opens Microsoft Word™ and uses the Word macros to format the legend, reference, rock type and time scale files. The resulting files with the output file prefix added to the start of each file name, are moved to "Output archive_B" folder. These final output files are text files of the data list (*prefix* Data_List.txt) and the time scale (*prefix* Time.txt), and Word™ files of the four legends (*prefix* Generalized_Legend, *prefix* Detailed_Legend, *prefix* Lithofacies_Legend and *prefix* Tect_Assemb_ Legend), the references (*prefix* Reference_List), the rock-type keywords (*prefix* Rock_Types), and the time scale (*prefix* Time_Scale).

Microsoft Word™ macros called by AppleScript™:

The AppleScript™ routines call various macros in Microsoft Word™. These macros are reproduced in Appendix 3. Copy the entire appendix into a word processor document and remove the bold titles. Recopy the modified document to the clipboard. Under the 'Tools' menu in Word, select 'Macros…' at the 'Macros' menu item. In the dialogue box, choose "Normal (Global Template)" from the pop-up menu on the 'Macros in:' line. Then click "Create" and call the new macro sheet "NewMacros" in the line 'Macro Name'. Paste the modified version of Appendix 3 into the macro sheet. Under the 'File' menu, save "Normal" and then choose "Close and Return to Microsoft Word".

If "NewMacros" already exists, then click "Edit" and add the Appendix 3 macros to the ones that are already in "NewMacros".

If you want to use different names or different paths from those described above, you must change the references to the macros in the two AppleScript™ routines. The references are presently shown as "Normal.NewMacros.*Macro_Name*" in Appendix 2.

Microsoft Word™ macro for formatting an extended reference list:

An extended reference list can be produced from the 'References' table by using the 'Export All…' command, after clicking the command button 'List extended references by NTS' on the 'References: Entry form'. The list shows all references for which an NTS area has been assigned in the 'NTS/Map IDs' table, sorted by NTS area.

The list is exported as a text file and requires formatting. This can be done automatically by using the macro "Format_refs" in Appendix 4. Copy and paste the macro into a macro sheet in Word; it can be added to the other macros in "NewMacros". Open the exported extended reference text file and run the macro.

Other Command Buttons

Open input table entry form:

Clicking on one of these buttons opens the entry form for that table.

Import or Export Entire Dataset

These three buttons allow data held in all the entry fields, except those in the 'Colours' table, to be exchanged between different copies of *GeoLegend* and to be exported to other database packages. Since the former situation is likely to be the most common, data have the default format for Helix RADE™, which is tabs for field delimiters and carriage returns for end-of-record markers; quotes are not used and different types of fields are not distinguished.

Import and replace current dataset:

Opens a dialogue box that allows you to 'Cancel' and return to 'Output Selection'. If you choose 'Delete and import new data', *GeoLegend* deletes the contents of the 'Polygon IDs' table and presents a dialogue box so that you can identify the file containing new data to be imported into the table. Identify the file and click "Import Text". The default settings for delimiters and headers can be changed by clicking the "Options" button in the dialogue box. Note that no special distinction should be made between alphanumeric and numeric strings in the text file; do NOT enclose alphanumeric strings in quotes. Make sure that the header option is set correctly for the data to be imported. An incorrect setting will either cause an error or will omit the first record.

Once the new contents have been imported into the 'Polygon IDs' table, *GeoLegend* deletes the contents of the 'Unit IDs' table and opens a dialogue box asking for the replacement file to be identified. Other tables are replaced in the same way.

Import and add to current dataset:

Opens a dialogue box that allows you to 'Cancel' and return to 'Output Selection'. If you choose 'Continue', *GeoLegend* opens a dialogue box so that you can identify the file containing new data to be imported into the 'Polygon IDs' table. These data will be added to the present contents of the 'Polygon IDs' table. Identify the file and click "Import Text". Settings are as in 'Import and replace current dataset'.

Once the new contents have been added to the 'Polygon IDs' table, *GeoLegend* opens a dialogue box asking for the file to be added to the 'Unit IDs' table to be identified. Other tables are added to in the same way, except for the 'Lithofacies categories' and 'Tectonic assemblage categories' tables, which only permit one record each; in these cases, the existing data are retained but can be changed if desired.

Export current dataset:

Opens a dialogue box that allows you to 'Cancel' and return to 'Output Selection'. If you choose 'Continue', *GeoLegend* exports to separate text files the contents of the entry fields in each of its input tables. File names, destinations and format have to be preset using the 'Set names and destinations of output files' under the 'Setup' menu. The default format is tabs for field delimiters and carriage returns for end-of-record markers.

To exchange data between two different copies of *GeoLegend*, use the 'Export current dataset' command to export data from one copy, and then import the resulting files into the new copy using the 'Import and replace current dataset' command.

Files of the entry fields in the input tables can be exported individually using the appropriate buttons on the 'Set names and destinations of output files' form. Exporting from the entry forms for these tables will export the contents of computed fields as well as entry fields.

APPENDIX 1: MAP INDEX WEB PAGES

A directory on the Web server is assumed to contain two subdirectories: "Index_Map" and "Folder_B". "Index_Map" contains permanent items such as the actual map, "nfgeol.gif", and the page header, "headergs2.jpg". "Folder_B" contains frequently revised text files of the references to the most recent maps and an "images" subdirectory. The latter has previews of maps and the header for the pop-up windows. To update the references for the Web index, click the 'Export HTML pages…' on the 'References: Entry form' to revise the version of "Folder_B" on your hard drive, add any new preview images to the "images" folder, and upload the entire "Folder_B" to the server, replacing the previous "Folder_B".

a. HTML and JavaScript for index map

```
<HTML>
<HEAD>
<TITLE>Geology Maps - Island of Newfoundland</TITLE>
<!-- Substitute the title for your area.-->

<!-- Pop-up windows require JavaScript 1.2. This routine prompts users of obsolete browsers
to update. -->
<script language="JavaScript1.2">
<!-- hide
var _js12_=1.2
//-->
</script>

<script language="JavaScript1.1">
<!-- hide
if (typeof _js12_=="undefined") {
alert("This index map works best with versions 4.x and above of Netscape Navigator and
Microsoft Internet Explorer. Users of older browsers should just click OK on the Javascript
error messages.");
}
//-->
</script>

<!-- This routine establishes the size and positions of the pop-up windows. -->
<script language="JavaScript">
<!-- hide

var x = screen.availWidth-360
var y = screen.availHeight-150

<!--Opens a window on the right side of the screen.-->
function openWin1(){
myWin=window.open("",    "displayWindow",   "width=320,height="+y+",dependent=1,sta-
tus=0,toolbar=1,menubar=1,scrollbars=1,resizable=1,  left="+x+",screenX="+x+",top=10,
screenY=10");
myWin.focus();
}

<!--Opens a window on the left side of the screen.-->
function openWin2(){
```

```
myWin=window.open("", "displayWindow", "width=320,height="+y+",dependent=1,status=0,toolbar=1,menubar=1,scrollbars=1,resizable=1,left=10,screenX=10,top=10,screenY=10");
myWin.focus();
}

//-->
</script>

</HEAD>

<BODY BGCOLOR="#FFFFFF" TEXT="#000000" LINK="BLUE" VLINK="RED" ALINK="GREEN">
<!-- Insert parameters for your page or just use <BODY>. -->

<P ALIGN="center"><IMG SRC="/Index_Map/headergs2.jpg" ALIGN="top" WIDTH="583" HEIGHT="65"
HSPACE="25" VSPACE="10"> <BR CLEAR="ALL">
<!-- Insert the name, path and dimensions of the image file you are using at the top of the page. -->
</P>

<TABLE BORDER="0" WIDTH="100%" CELLSPACING="1" CELLPADDING="3" ALIGN="left">
<TR>

<!--The left 25% of the table is used for links to other parts of the Web site. Replace as appropriate.-->
<TD WIDTH="25%" VALIGN="top" BGCOLOR="#C8B4B4">
<P><BR>
<P><BR>
<P><BR>
<FONT FACE="Arial Narrow" COLOR="#800000"><A HREF="/publications/minassrep.html" STYLE="text-decoration: none; color: rgb(128,0,0)">AssessmentReports</A></FONT>
<BR>
<!--And so on. Insert other links as required.-->

<!--The right 75% of the table contains the index map.-->
<TD WIDTH="75%" VALIGN="top" BGCOLOR="#FFFFFF">

<P ALIGN=right><FONT FACE="Verdana, Arial, helvetica"><SMALL><A HREF="labmap.html">Labrador Index</A></SMALL></FONT>
<!--This links to another index map, for Labrador.-->

<CENTER>

<!--Instructions for unusual behaviour of Netscape 4.x on a Macintosh computer.-->
<script language="JavaScript">
<!-- hide
if ((navigator.appName.indexOf("Netscape") != -1) && (navigator.platform.indexOf("Mac") != -1))
document.write("Mac Netscape 4.x users reactivate the link pointer by moving it off the map and back again");
document.close();
//-->
</script>

<!--The image map starts here. The map can be created using utilities like Mapper 1.0, available on shareware FTP sites.-->
<MAP NAME="map1">
```

<!--The first active area is the button for opening the full reference list and links to "Full.html" in "Folder_B", which it opens in a window on the left side of the screen.-->
<AREA SHAPE="rect" COORDS="313,84,467,133" HREF="Folder_B/Full.html" TARGET="displayWindow" onClick="openWin2()">

<!--The second active area is NTS 1L/16 and links to "01L_16.html" in "Folder_B", which it opens in a window on the left side of the screen.-->
<AREA SHAPE="rect" COORDS="332,462,366,486" HREF="Folder_B/01L_16.html" TARGET="displayWindow" onClick="openWin2()">

<!--Active areas should follow for each NTS area. This one links to "11P_10.html" in "Folder_B" and opens a window on the right side of the screen.-->
<AREA SHAPE="rect" COORDS="175,394,208,418" HREF="Folder_B/11P_10.html" TARGET="displayWindow" onClick="openWin1()">

<!--And again on the left side of the screen.-->
<AREA SHAPE="rect" COORDS="267,7,295,29" HREF="Folder_B/02M_14.html" TARGET="displayWindow" onClick="openWin2()">
</MAP>

<!--The actual image of the index map is "nfgeol.gif" in the "images" directory and is opened with instructions to use image map "map1".-->
<IMG USEMAP="#map1" SRC="/Index_Map/nfgeol.gif" HEIGHT="525" WIDTH="483" BORDER="0">

<BR CLEAR=ALL>
</TD></TR></TABLE><BR CLEAR=ALL>
<!--At the bottom of the page are links to other parts of the site. Replace as appropriate.-->
<HR><CENTER><FONT FACE="Verdana, Arial, helvetica"><SMALL> <A HREF="http://www.geosurv.gov.nf.ca">Geological Survey</A> | <A HREF="http://www.gov.nf.ca/ mines&en/MINENER2.htm">Mines Branch</A> | <A HREF="http://www.gov.nf.ca/ mines&en/">Department of Mines & Energy</A> | <A HREF="http://www.gov. nf.ca/">Government of Newfoundland and Labrador</A></SMALL></FONT></CENTER></BODY></HTML>

b. HTML for full reference list (file "Full.html")

<HTML>
<HEAD>
<TITLE>Complete Listing by NTS Area
</TITLE>
</HEAD>

<!--The <BODY> parameters can be edited after clicking 'Export HTML files…'.-->
<BODY BGCOLOR="#FFFFFF" TEXT="#000000" LINK="#0000FF" VLINK="#666633" ALINK="#00BB00">

<!--A header image, named "header.jpg", should be placed in the "images" folder in "Folder_B".-->
<CENTER><IMG SRC="images/header.jpg" >
<P>

<!--The region (following "FOR") can be edited after clicking 'Export HTML files…' in GeoLegend.-->
<FONT SIZE="+1"><B>INDEX TO THE MOST RECENT GEOLOGICAL

MAPS FOR THE ISLAND OF NEWFOUNDLAND</B></FONT>
<P>

<!--GeoLegend automatically date stamps the full reference list when the HTML files are updated.-->

```
<B>Updated January 8, 2002</CENTER></B>
<P>

<!--The reference for the regional compilation map can be changed after clicking 'Export HTML files…'.-->
<B>Regional Compilation Map:</B>
<BR>Colman-Sadd, S.P., Hayes, J.P. and Knight, I.
<BR>1990: Geology of the Island of Newfoundland. Map 90-01. Scale: 1:1 000 000. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Branch. GS# NFLD/2192
<P>

<!--References are listed by NTS area.-->
<B>01K/11</B>
<BR>King, A.F. (compiler)
<BR>1988: Geology of the Avalon Peninsula, Newfoundland (parts of 1K, 1L, 1M, 1N and 2C). Map 88-001 (coloured). Scale: 1:250 000. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division. GS# NFLD/1680
<P>
Williams, H. and King, A.F.
<BR>1979: Geology, Trepassey, Newfoundland. Map 1468A. Scale: 1:250 000. In Trepassey map area, Newfoundland. Geological Survey of Canada, Memoir 389, 24 pages, enclosure (map). GS# 001K/0011 (viewing only)
<P>

<B>01K/12</B>
<BR>King, A.F. (compiler)
<BR>1988: Geology of the Avalon Peninsula, Newfoundland (parts of 1K, 1L, 1M, 1N and 2C). Map 88-001 (coloured). Scale: 1:250 000. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division. GS# NFLD/1680
<P>
Williams, H. and King, A.F.
<BR>1979: Geology, Trepassey, Newfoundland. Map 1468A. Scale: 1:250 000. In Trepassey map area, Newfoundland. Geological Survey of Canada, Memoir 389, 24 pages, enclosure (map). GS# 001K/0011 (viewing only)
<P>

<!--And so on to the last NTS area for the region.-->

<B>12P/09</B>
<BR>Knight, I. and Edwards, J.
<BR>1986c: Big Brook, Newfoundland. Map 86-025. Scale: 1:50 000. Government of Newfoundland and Labrador, Department of Mines and Energy, Mineral Development Division, Open File 012P/09/0058. Blueline paper. GS# 012P/09/0058
<P>
</BODY>
</HTML>
```

c. HTML for an individual NTS area (file "02E_04.html")

```
<HTML>
<HEAD>

<!--Each page is named and titled by its NTS number.-->
<TITLE>02E/04
</TITLE>
</HEAD>

<!--The <BODY> parameters can be edited after clicking 'Export HTML files…'.-->
```

```
<BODY BGCOLOR="#FFFFFF" TEXT="#000000" LINK="#0000FF" VLINK="#666633" ALINK="#00BB00">

<!--A header image, named "header.jpg", should be placed in the "images" folder in "Folder_B".-->
<CENTER><IMG SRC=" images/header.jpg"></CENTER>
<P>

<!--The NTS number is followed by a list of references for the area. The first reference, by Dickson, has a link to an image of the map in the "images" folder. The link is automatically inserted if the 'Image file' field is filled in the 'References' table.-->
<B>02E/04</B>
<BR>Dickson, W.L.
<BR>2000c: Geology of the Hodges Hill (NTS 2E/4) map area, north central Newfoundland. Map 2000-23. Scale: 1:50 000. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey, Open File 002E/04/1082. Computer generated. GS# 002E/04/1082
<A HREF="images/002E_04_1082.gif">Preview Map</A>

<P>
O'Brien, B.H.
<BR>1994a: Geology of the region around Botwood (parts of 2E/3, 4, 6), north-central Newfoundland. Map 93-168. Scale: 1:50 000. Government of Newfoundland and Labrador, Department of Mines and Energy, Geological Survey Branch, Open File 002E/0869. Blueline paper. GS# 002E/0869
<P>

<B>CONTACTS
<BR>For publications and general information:</B>

<!--This geologist was flagged as the "general contact" on the 'Geologist contact info' form and appears on pages for all NTS areas.-->
<BR>Norman Mercer
<BR>Geological Survey of Newfoundland and Labrador
<BR>(709) 729-6193
<BR><A HREF="mail to:nlm@zeppo.geosurv.gov.nf.ca">nlm@zeppo.geosurv.gov.nf.ca</A>
<P>

<B>For specific geological information:</B>

<!--These geologists were listed specifically for this area in the 'NTS areas' table and the third one was given a speciality ("Intrusive rocks").-->
<BR>Lawson Dickson
<BR>Geological Survey of Newfoundland and Labrador
<BR>(709) 729-2453
<BR><A HREF="mail to:wld@zeppo.geosurv.gov.nf.ca">wld@zeppo.geosurv.gov.nf.ca</A>

<P>Brian O'Brien
<BR>Geological Survey of Newfoundland and Labrador
<BR>(709) 729-3994
<BR><A HREF="mail to:bhob@zeppo.geosurv.gov.nf.ca">bhob@zeppo.geosurv.gov.nf.ca
</A>

<P>Andrew Kerr: Intrusive rocks
<BR>Geological Survey of Newfoundland and Labrador
<BR>(709) 729-2164
<BR><A HREF="mail to:akr@zeppo.geosurv.gov.nf.ca">akr@zeppo.geosurv.gov.nf.ca</A>

</BODY>
</HTML>
```

APPENDIX 2: APPLESCRIPTS FOR FORMATTING AND ORGANIZING OUTPUT FILES (MacOS 9.2 or lower)

a. AppleScript™ Legend Routine

(Substitute the correct paths on your computer for "Hard Drive:Folder_A:Output folder_A:" and "Hard Drive:Folder_A:Output archive_A:" throughout the routine *)*

```
on adding folder items to this_folder after receiving added_items
    tell application "Finder"
        set numFiles to (count files in folder "Hard Drive:Folder_A:Output folder_A:")
    end tell
    if numFiles is equal to 7 then

        tell application "Microsoft Word"
            activate
            do Visual Basic "       ChangeFileOpenDirectory  _
        \" Hard Drive:Folder_A:Output folder_A:\""
            do Visual Basic "       Documents.Open FileName:=\"legend\", Confirm
                                    Conversions:=False, ReadOnly:= _
        False, AddToRecentFiles:=False, PasswordDocument:=\"\", PasswordTemplate:=_
        \"\", Revert:=False, WritePasswordDocument:=\"\", WritePasswordTemplate:=\"\", _
        Format:=wdOpenFormatAuto"
            do Visual Basic "       Application.Run MacroName:=\"Normal.New
                                    Macros.Legendscript\""
            do Visual Basic "       Documents.Open FileName:=\"mapref\", Confirm
                                    Conversions:=False, ReadOnly:= _
        False, AddToRecentFiles:=False, PasswordDocument:=\"\", PasswordTemplate:=_
        \"\", Revert:=False, WritePasswordDocument:=\"\", WritePasswordTemplate:=\"\", _
        Format:=wdOpenFormatAuto"
            do Visual Basic "       Application.Run MacroName:=\"Normal.New
                                    Macros.Mapref\""
            close window 1
            do Visual Basic "       Selection.EndKey Unit:=wdLine"
            paste
            do Visual Basic "       Documents.Open FileName:=\"legref\", Confirm
                                    Conversions:=False, ReadOnly:= _
        False, AddToRecentFiles:=False, PasswordDocument:=\"\", PasswordTemplate:=_
        \"\", Revert:=False, WritePasswordDocument:=\"\", WritePasswordTemplate:=\"\", _
        Format:=wdOpenFormatAuto"
            do Visual Basic "       Application.Run MacroName:=\"Normal.New
                                    Macros.Legref\""
            close window 1
            paste
            do Visual Basic "       Documents.Open FileName:=\"prefix\", Confirm
                                    Conversions:=False, ReadOnly:= _
        False, AddToRecentFiles:=False, PasswordDocument:=\"\", PasswordTemplate:=_
        \"\", Revert:=False, WritePasswordDocument:=\"\", WritePasswordTemplate:=\"\", _
        Format:=wdOpenFormatAuto"
            do Visual Basic "       Application.Run MacroName:=\"Normal.New
                                    Macros.Name\""
            close window 1
            do Visual Basic "       Application.Run MacroName:=\"Normal.New
                                    Macros.Paginate\""
            close window 1
        end tell
```

```
        tell application "Finder"
            activate
            set clip_data to the clipboard

            select file "dominant" of folder "Hard Drive:Folder_A:Output folder_A:"
            set name of selection to clip_data & "key.txt"
            set name_1 to name of selection
            select file "full" of folder "Hard Drive:Folder_A:Output folder_A:"
            set name of selection to clip_data & "lab.txt"
            set name_2 to name of selection
            select file "legend" of folder "Hard Drive:Folder_A:Output folder_A:"
            set name of selection to clip_data & " Legend"
            set name_3 to name of selection
            select file "colours" of folder "Hard Drive:Folder_A:Output folder_A:"
            set name of selection to clip_data & "colrgb.txt"
            set name_4 to name of selection

            select {file name_1 of folder "Hard Drive:Folder_A:Output folder_A:", ¬
                file name_2 of folder "Hard Drive:Folder_A:Output folder_A:", ¬
                file name_3 of folder "Hard Drive:Folder_A:Output folder_A:", ¬
                file name_4 of folder "Hard Drive:Folder_A:Output folder_A:"}
            move selection to folder " Hard Drive:Folder_A:Output archive_A:"

            select every item in folder "Hard Drive:Folder_A:Output folder_A:"
            delete selection

            open file name_3 of folder "Hard Drive:Folder_A:Output archive_A:"

        end tell

    end if
end adding folder items to
```

b. AppleScript™ GIS Routine

(Substitute the correct paths on your computer for "Hard Drive:Folder_A:Output folder_B:" and "Hard Drive:Folder_A:Output archive_B:" throughout the routine *)*

```
on adding folder items to this_folder after receiving added_items
    tell application "Finder"
        set numFiles to (count files in folder "Hard Drive:Folder_A:Output folder_B:")
    end tell

    if numFiles is equal to 9 then
        tell application "Finder"
            activate
            select file "time" of folder "Hard Drive:Folder_A:Output folder_B:"
            copy selection to folder "Hard Drive:Folder_A:Output archive_B:"
        end tell

        tell application "Microsoft Word"
            activate

            do Visual Basic "       ChangeFileOpenDirectory  _
        \"Hard Drive:Folder_A:Output archive_B:\""
```

```
    do Visual Basic "      Documents.Open FileName:=\"time\", Confirm
                           Conversions:=False, ReadOnly:= _
False, AddToRecentFiles:=False, PasswordDocument:=\"\", PasswordTemplate:=_
\"\", Revert:=False, WritePasswordDocument:=\"\", WritePasswordTemplate:=\"\", _
Format:=wdOpenFormatAuto"
    do Visual Basic "      Application.Run MacroName:=\"Normal.New
                           Macros.Timetxt\""
    close window 1
    do Visual Basic "      ChangeFileOpenDirectory  _
\"Hard Drive:Folder_A:Output folder_B:\""
    do Visual Basic "      Documents.Open FileName:=\"legend\", Confirm
                           Conversions:=False, ReadOnly:= _
False, AddToRecentFiles:=False, PasswordDocument:=\"\", PasswordTemplate:=_
\"\", Revert:=False, WritePasswordDocument:=\"\", WritePasswordTemplate:=\"\", _
Format:=wdOpenFormatAuto"
    do Visual Basic "      Application.Run MacroName:=\"Normal.New
                           Macros.Detailed_legend\""
    do Visual Basic "      Documents.Open FileName:=\"prefix\", Confirm
                           Conversions:=False, ReadOnly:= _
False, AddToRecentFiles:=False, PasswordDocument:=\"\", PasswordTemplate:=_
\"\", Revert:=False, WritePasswordDocument:=\"\", WritePasswordTemplate:=\"\", _
Format:=wdOpenFormatAuto"
    do Visual Basic "      Application.Run MacroName:=\"Normal.New
                           Macros.Name\""
    close window 1
    do Visual Basic "      Application.Run MacroName:=\"Normal.New
                           Macros.Paginate\""
    close window 1
    do Visual Basic "      Documents.Open FileName:=\"generalized\", Confirm
                           Conversions:=False, ReadOnly:= _
False, AddToRecentFiles:=False, PasswordDocument:=\"\", PasswordTemplate:=_
\"\", Revert:=False, WritePasswordDocument:=\"\", WritePasswordTemplate:=\"\", _
Format:=wdOpenFormatAuto"
    do Visual Basic "      Application.Run MacroName:=\"Normal.New
                           Macros.General_legend\""
    do Visual Basic "      Application.Run MacroName:=\"Normal.New
                           Macros.Paginate\""
    close window 1

    do Visual Basic "      Documents.Open FileName:=\"lithofacies\", Confirm
                           Conversions:=False, ReadOnly:= _
False, AddToRecentFiles:=False, PasswordDocument:=\"\", PasswordTemplate:=_
\"\", Revert:=False, WritePasswordDocument:=\"\", WritePasswordTemplate:=\"\", _
Format:=wdOpenFormatAuto"
    do Visual Basic "      Application.Run MacroName:=\"Normal.New
                           Macros.Lithofacies_legend\""
    do Visual Basic "      Application.Run MacroName:=\"Normal.New
                           Macros.Paginate\""
    close window 1
    do Visual Basic "      Documents.Open FileName:=\"assemblage\", Confirm
                           Conversions:=False, ReadOnly:= _
False, AddToRecentFiles:=False, PasswordDocument:=\"\", PasswordTemplate:=_
\"\", Revert:=False, WritePasswordDocument:=\"\", WritePasswordTemplate:=\"\", _
Format:=wdOpenFormatAuto"
    do Visual Basic "      Application.Run MacroName:=\"Normal.New
                           Macros.Tect_assemb_legend\""
    do Visual Basic "      Application.Run MacroName:=\"Normal.New
                           Macros.Paginate\""
    close window 1
```

```
        do Visual Basic "       Documents.Open FileName:=\"references\", Confirm
                                Conversions:=False, ReadOnly:= _
False, AddToRecentFiles:=False, PasswordDocument:=\"\", PasswordTemplate:=_
\"\", Revert:=False, WritePasswordDocument:=\"\", WritePasswordTemplate:=\"\", _
Format:=wdOpenFormatAuto"
        do Visual Basic "       Application.Run MacroName:=\"Normal.New
                                Macros.Referencescript\""
        do Visual Basic "       Application.Run MacroName:=\"Normal.New
                                Macros.Paginate\""
        close window 1
        do Visual Basic "       Documents.Open FileName:=\"time\", Confirm
                                Conversions:=False, ReadOnly:= _
False, AddToRecentFiles:=False, PasswordDocument:=\"\", PasswordTemplate:=_
\"\", Revert:=False, WritePasswordDocument:=\"\", WritePasswordTemplate:=\"\", _
Format:=wdOpenFormatAuto"
        do Visual Basic "       Application.Run MacroName:=\"Normal.New
                                Macros.Timescalescript\""
        do Visual Basic "       Application.Run MacroName:=\"Normal.New
                                Macros.Paginate\""
        close window 1
        do Visual Basic "       Documents.Open FileName:=\"rock-type\", Confirm
                                Conversions:=False, ReadOnly:= _
False, AddToRecentFiles:=False, PasswordDocument:=\"\", PasswordTemplate:=_
\"\", Revert:=False, WritePasswordDocument:=\"\", WritePasswordTemplate:=\"\", _
Format:=wdOpenFormatAuto"
        do Visual Basic "       Application.Run MacroName:=\"Normal.New
                                Macros.Rocktypescript\""
        do Visual Basic "       Application.Run MacroName:=\"Normal.New
                                Macros.Paginate\""
        close window 1

    end tell

    tell application "Finder"
        activate
        set clip_data to the clipboard

        select file "time" of folder "Hard Drive:Folder_A:Output archive_B:"
        set name of selection to clip_data & " Time.txt"

        select file "legend" of folder "Hard Drive:Folder_A:Output folder_B:"
        set name of selection to clip_data & " Detailed_Legend"
        set name_1 to name of selection
        select file "lithofacies" of folder "Hard Drive:Folder_A:Output folder_B:"
        set name of selection to clip_data & " Lithofacies_Legend"
        set name_2 to name of selection
        select file "assemblage" of folder "Hard Drive:Folder_A:Output folder_B:"
        set name of selection to clip_data & " Tect_Assemb_Legend"
        set name_3 to name of selection
        select file "generalized" of folder "Hard Drive:Folder_A:Output folder_B:"
        set name of selection to clip_data & " Generalized_Legend"
        set name_4 to name of selection
        select file "time" of folder "Hard Drive:Folder_A:Output folder_B:"
        set name of selection to clip_data & " Time_Scale"
        set name_5 to name of selection
        select file "rock-type" of folder "Hard Drive:Folder_A:Output folder_B:"
        set name of selection to clip_data & " Rock_Types"
        set name_6 to name of selection
        select file "references" of folder "Hard Drive:Folder_A:Output folder_B:"
```

```
            set name of selection to clip_data & " Reference_List"
            set name_7 to name of selection
            select file "data" of folder "Hard Drive:Folder_A:Output folder_B:"
            set name of selection to clip_data & " Data_List.txt"
            set name_8 to name of selection

            select {file name_1 of folder "Hard Drive:Folder_A:Output folder_B:", ¬
                  file name_2 of folder "Hard Drive:Folder_A:Output folder_B:", ¬
                  file name_3 of folder "Hard Drive:Folder_A:Output folder_B:", ¬
                  file name_4 of folder "Hard Drive:Folder_A:Output folder_B:", ¬
                  file name_5 of folder "Hard Drive:Folder_A:Output folder_B:", ¬
                  file name_6 of folder "Hard Drive:Folder_A:Output folder_B:", ¬
                  file name_7 of folder "Hard Drive:Folder_A:Output folder_B:", ¬
                  file name_8 of folder "Hard Drive:Folder_A:Output folder_B:"}
            move selection to folder "Hard Drive:Folder_A:Output archive_B:"

            select every item in folder "Hard Drive:Folder_A:Output folder_B:"
            delete selection

         end tell
      end if
end adding folder items to
```

APPENDIX 3: MICROSOFT WORD™ MACROS CALLED BY APPLESCRIPT™

Copy this appendix from the digital version of this manual to a word processor and remove the bold titles. Then copy it into a macro sheet in Word called "NewMacros" stored in "Normal (Global Template)". Any changes in the macro names or paths should be matched by changes in the AppleScript™ routines.

a. Legendscript

```
Sub Legendscript()
'
' Legendscript Macro
'
    Selection.Document.Kind = wdDocumentNotSpecified
    Selection.Range.AutoFormat
    Selection.Document.Kind = wdDocumentNotSpecified
    Selection.Range.AutoFormat
    Selection.WholeStory
    Selection.Font.Name = "Palatino"
    Selection.Font.Size = 10
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    With Selection.Find
        .Text = "^t^t"
        .Replacement.Text = "^t"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p^t"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p^p"
        .Replacement.Text = "^p"
```

```
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p"
        .Replacement.Text = "^p^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^t"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "%^p"
        .Replacement.Text = "^t"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    Selection.Find.Replacement.Font.Size = 12
    With Selection.Find
```

```
        .Text = "Ω*Ω"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = True
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = True
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    Selection.Find.Replacement.Font.Size = 14
    With Selection.Find
        .Text = "Δ*Δ"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = True
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = True
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "Δ"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "Ω"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.ParagraphFormat.LeftIndent = InchesToPoints(0)
    Selection.ParagraphFormat.LeftIndent = InchesToPoints(0.75)
    Selection.ParagraphFormat.FirstLineIndent = InchesToPoints(-0.75)
    ActiveDocument.SaveAs FileName:="Legend", FileFormat:=wdFormatDocument, _
        LockComments:=False, Password:="", AddToRecentFiles:=True, WritePassword _
```

Certain special □ characters may not □ be visible in the full □ version of Adobe □ Acrobat. They are □ visible in Acrobat □ Reader 4.0 and □ above.

```
        :="", ReadOnlyRecommended:=False, EmbedTrueTypeFonts:=False, _
        SaveNativePictureFormat:=False, SaveFormsData:=False, SaveAsAOCELetter:= _
        False
End Sub
```

b. Mapref

```
Sub Mapref()
'
' Mapref Macro
'
    Selection.Document.Kind = wdDocumentNotSpecified
    Selection.Range.AutoFormat
    Selection.WholeStory
    Selection.Font.Name = "Palatino"
    Selection.Font.Size = 10
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    With Selection.Find
        .Text = "^p^p"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "Δ^p"
        .Replacement.Text = "^p^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "Ω"
        .Replacement.Text = "^p^t"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
```

```
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "References used as"
        .Replacement.Text = "^pReferences used as"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.ParagraphFormat.CloseUp
    With Selection.ParagraphFormat
        .LeftIndent = InchesToPoints(0.5)
        .RightIndent = InchesToPoints(0)
        .SpaceBefore = 0
        .SpaceAfter = 0
        .LineSpacingRule = wdLineSpaceSingle
        .Alignment = wdAlignParagraphLeft
        .WidowControl = True
        .KeepWithNext = False
        .KeepTogether = False
        .PageBreakBefore = False
        .NoLineNumber = False
        .Hyphenation = True
        .FirstLineIndent = InchesToPoints(-0.5)
        .OutlineLevel = wdOutlineLevelBodyText
    End With
    Selection.Copy
    ActiveDocument.SaveAs FileName:="Mapref", FileFormat:=wdFormatDocument, _
        LockComments:=False, Password:="", AddToRecentFiles:=True, WritePassword _
        :="", ReadOnlyRecommended:=False, EmbedTrueTypeFonts:=False, _
        SaveNativePictureFormat:=False, SaveFormsData:=False, SaveAsAOCELetter:= _
        False
End Sub
```

c. Legref

```
Sub Legref()
'
' Legref Macro
'
'
    Selection.Document.Kind = wdDocumentNotSpecified
    Selection.Range.AutoFormat
    Selection.WholeStory
    Selection.Font.Name = "Palatino"
    Selection.Font.Size = 10
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    With Selection.Find
        .Text = "^p^p"
```

```
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "Δ^p"
        .Replacement.Text = "^p^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "Ω"
        .Replacement.Text = "^p^t"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.ParagraphFormat.CloseUp
    With Selection.ParagraphFormat
        .LeftIndent = InchesToPoints(0.5)
        .RightIndent = InchesToPoints(0)
        .SpaceBefore = 0
        .SpaceAfter = 0
        .LineSpacingRule = wdLineSpaceSingle
        .Alignment = wdAlignParagraphLeft
        .WidowControl = True
        .KeepWithNext = False
        .KeepTogether = False
        .PageBreakBefore = False
        .NoLineNumber = False
        .Hyphenation = True
        .FirstLineIndent = InchesToPoints(-0.5)
        .OutlineLevel = wdOutlineLevelBodyText
    End With
    Selection.Copy
```

```
    ActiveDocument.SaveAs FileName:="Mapref", FileFormat:=wdFormatDocument, _
        LockComments:=False, Password:="", AddToRecentFiles:=True, WritePassword _
        :="", ReadOnlyRecommended:=False, EmbedTrueTypeFonts:=False, _
        SaveNativePictureFormat:=False, SaveFormsData:=False, SaveAsAOCELetter:= _
        False
End Sub
```

d. Name

```
Sub Name()
'
' Name Macro
'
    Selection.WholeStory
    Selection.Font.Name = "Palatino"
    Selection.Font.Bold = wdToggle
    Selection.Font.Size = 14
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    With Selection.Find
        .Text = "^p"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Copy
    ActiveDocument.SaveAs FileName:="Name", FileFormat:=wdFormatDocument, _
        LockComments:=False, Password:="", AddToRecentFiles:=True, WritePassword _
        :="", ReadOnlyRecommended:=False, EmbedTrueTypeFonts:=False, _
        SaveNativePictureFormat:=False, SaveFormsData:=False, SaveAsAOCELetter:= _
        False
End Sub
```

e. Paginate

```
Sub Paginate()
'
' Paginate Macro
'
    Selection.HomeKey Unit:=wdStory
    Selection.Paste
    If ActiveWindow.View.SplitSpecial <> wdPaneNone Then
        ActiveWindow.Panes(2).Close
    End If
    If ActiveWindow.ActivePane.View.Type = wdNormalView Or ActiveWindow. _
        ActivePane.View.Type = wdOutlineView Or ActiveWindow.ActivePane.View.Type _
         = wdMasterView Then
        ActiveWindow.ActivePane.View.Type = wdPageView
    End If
```

```
    ActiveWindow.ActivePane.View.SeekView = wdSeekCurrentPageHeader
    Selection.MoveDown Unit:=wdLine, Count:=1
    Selection.TypeText Text:=vbTab
    Selection.Fields.Add Range:=Selection.Range, Type:=wdFieldPage
    Selection.MoveUp Unit:=wdLine, Count:=1
    Selection.TypeText Text:=vbTab & vbTab
    Selection.Fields.Add Range:=Selection.Range, Type:=wdFieldDate
    ActiveWindow.ActivePane.View.SeekView = wdSeekMainDocument
    ActiveDocument.Save
End Sub
```

f. Timetxt

```
Sub Timetxt()
'
' Time.txt Macro
'
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    With Selection.Find
        .Text = "*"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "_"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    ActiveDocument.SaveAs FileName:="time", FileFormat:=wdFormatDOSText,
    LockComments:=False, Password:= _
        "",AddToRecentFiles:=True, WritePassword:="", ReadOnlyRecommended:=False _
        , EmbedTrueTypeFonts:=False, SaveNativePictureFormat:=False, _
        SaveFormsData:=False, SaveAsAOCELetter:=False
End Sub
```

g. Detailed_legend

```
Sub Detailed_legend()
'
```

```
' Detailed_legend Macro
'
    Selection.Document.Kind = wdDocumentNotSpecified
    Selection.Range.AutoFormat
    Selection.Document.Kind = wdDocumentNotSpecified
    Selection.Range.AutoFormat
    Selection.WholeStory
    Selection.Font.Name = "Palatino"
    Selection.Font.Size = 10
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    With Selection.Find
        .Text = "^t^t"
        .Replacement.Text = "^t"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p^t"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p^p"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
```

```
With Selection.Find
    .Text = "^p"
    .Replacement.Text = "^p^p"
    .Forward = True
    .Wrap = wdFindContinue
    .Format = False
    .MatchCase = False
    .MatchWholeWord = False
    .MatchWildcards = False
    .MatchSoundsLike = False
    .MatchAllWordForms = False
End With
Selection.Find.Execute Replace:=wdReplaceAll
With Selection.Find
    .Text = "^t"
    .Replacement.Text = "^p"
    .Forward = True
    .Wrap = wdFindContinue
    .Format = False
    .MatchCase = False
    .MatchWholeWord = False
    .MatchWildcards = False
    .MatchSoundsLike = False
    .MatchAllWordForms = False
End With
Selection.Find.Execute Replace:=wdReplaceAll
With Selection.Find
    .Text = "%^p"
    .Replacement.Text = "^t"
    .Forward = True
    .Wrap = wdFindContinue
    .Format = False
    .MatchCase = False
    .MatchWholeWord = False
    .MatchWildcards = False
    .MatchSoundsLike = False
    .MatchAllWordForms = False
End With
Selection.Find.Execute Replace:=wdReplaceAll
Selection.Find.ClearFormatting
Selection.Find.Replacement.ClearFormatting
Selection.Find.Replacement.Font.Size = 12
With Selection.Find
    .Text = "Ω*Ω"
    .Replacement.Text = ""
    .Forward = True
    .Wrap = wdFindContinue
    .Format = True
    .MatchCase = False
    .MatchWholeWord = False
    .MatchWildcards = True
    .MatchSoundsLike = False
    .MatchAllWordForms = False
End With
Selection.Find.Execute Replace:=wdReplaceAll
Selection.Find.ClearFormatting
Selection.Find.Replacement.ClearFormatting
Selection.Find.Replacement.Font.Size = 14
With Selection.Find
```

```
        .Text = "Δ*Δ"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = True
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = True
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "Δ"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "Ω"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.ParagraphFormat.LeftIndent = InchesToPoints(0)
    Selection.ParagraphFormat.LeftIndent = InchesToPoints(0.75)
    Selection.ParagraphFormat.FirstLineIndent = InchesToPoints(-0.75)
    Selection.WholeStory
    Selection.HomeKey Unit:=wdLine
    Selection.TypeText Text:="DETAILED LEGEND"
    Selection.TypeParagraph
    Selection.TypeParagraph
    Selection.MoveUp Unit:=wdLine, Count:=2
    Selection.ParagraphFormat.Alignment = wdAlignParagraphCenter
        If ActiveWindow.View.SplitSpecial <> wdPaneNone Then
        ActiveWindow.Panes(2).Close
    End If
    If ActiveWindow.ActivePane.View.Type = wdNormalView Or ActiveWindow. _
        ActivePane.View.Type = wdOutlineView Or ActiveWindow.ActivePane.View.Type _
         = wdMasterView Then
        ActiveWindow.ActivePane.View.Type = wdPageView
    End If
    ActiveWindow.ActivePane.View.SeekView = wdSeekCurrentPageHeader
    Selection.MoveDown Unit:=wdLine, Count:=1
    Selection.TypeText Text:=vbTab
    Selection.Fields.Add Range:=Selection.Range, Type:=wdFieldPage
```

```
    ActiveWindow.ActivePane.View.SeekView = wdSeekMainDocument
    ActiveDocument.SaveAs FileName:="legend", FileFormat:=wdFormatDocument, _
        LockComments:=False, Password:="", AddToRecentFiles:=True, WritePassword _
        :="", ReadOnlyRecommended:=False, EmbedTrueTypeFonts:=False, _
        SaveNativePictureFormat:=False, SaveFormsData:=False, SaveAsAOCELetter:= _
        False
End Sub
```

h. General_legend

```
Sub General_legend()
'
' General_legend Macro
'
    Selection.Document.Kind = wdDocumentNotSpecified
    Selection.Range.AutoFormat
    Selection.Document.Kind = wdDocumentNotSpecified
    Selection.Range.AutoFormat
    Selection.WholeStory
    Selection.Font.Name = "Palatino"
    Selection.Font.Size = 10
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    With Selection.Find
        .Text = "^t^t"
        .Replacement.Text = "^t"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p^t"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p^p"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
```

```
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p"
        .Replacement.Text = "^p^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^t"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "%^p"
        .Replacement.Text = "^t"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    Selection.Find.Replacement.Font.Size = 12
    With Selection.Find
        .Text = "Ω*Ω"
        .Replacement.Text = ""
        .Forward = True
```

```
        .Wrap = wdFindContinue
        .Format = True
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = True
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    Selection.Find.Replacement.Font.Size = 14
    With Selection.Find
        .Text = "Δ*Δ"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = True
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = True
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "Δ"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "Ω"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.ParagraphFormat.LeftIndent = InchesToPoints(0)
    Selection.ParagraphFormat.LeftIndent = InchesToPoints(0.75)
    Selection.ParagraphFormat.FirstLineIndent = InchesToPoints(-0.75)
    Selection.WholeStory
    Selection.HomeKey Unit:=wdLine
    Selection.TypeText Text:="GENERALIZED LEGEND"
    Selection.TypeParagraph
    Selection.TypeParagraph
    Selection.MoveUp Unit:=wdLine, Count:=2
```

```
    Selection.ParagraphFormat.Alignment = wdAlignParagraphCenter
        If ActiveWindow.View.SplitSpecial <> wdPaneNone Then
        ActiveWindow.Panes(2).Close
    End If
    If ActiveWindow.ActivePane.View.Type = wdNormalView Or ActiveWindow. _
        ActivePane.View.Type = wdOutlineView Or ActiveWindow.ActivePane.View.Type _
         = wdMasterView Then
        ActiveWindow.ActivePane.View.Type = wdPageView
    End If
    ActiveWindow.ActivePane.View.SeekView = wdSeekCurrentPageHeader
    Selection.MoveDown Unit:=wdLine, Count:=1
    Selection.TypeText Text:=vbTab
    Selection.Fields.Add Range:=Selection.Range, Type:=wdFieldPage
    ActiveWindow.ActivePane.View.SeekView = wdSeekMainDocument
    ActiveDocument.SaveAs FileName:="generalized", FileFormat:=wdFormatDocument, _
        LockComments:=False, Password:="", AddToRecentFiles:=True, WritePassword _
        :="", ReadOnlyRecommended:=False, EmbedTrueTypeFonts:=False, _
        SaveNativePictureFormat:=False, SaveFormsData:=False, SaveAsAOCELetter:= _
        False
End Sub
```

i. Lithofacies_legend

```
Sub Lithofacies_legend()
'
' Lithofacies_legend Macro
'
    Selection.Document.Kind = wdDocumentNotSpecified
    Selection.Range.AutoFormat
    Selection.Document.Kind = wdDocumentNotSpecified
    Selection.Range.AutoFormat
    Selection.WholeStory
    Selection.Font.Name = "Palatino"
    Selection.Font.Size = 10
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    With Selection.Find
        .Text = "^t^t"
        .Replacement.Text = "^t"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p^t"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
```

```
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p^p"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p"
        .Replacement.Text = "^p^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^t"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "%^p"
        .Replacement.Text = "^t"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
```

```
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    Selection.Find.Replacement.Font.Size = 12
    With Selection.Find
        .Text = "Ω*Ω"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = True
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = True
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    Selection.Find.Replacement.Font.Size = 14
    With Selection.Find
        .Text = "Δ*Δ"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = True
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = True
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "Δ"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "Ω"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
```

```
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.ParagraphFormat.LeftIndent = InchesToPoints(0)
    Selection.ParagraphFormat.LeftIndent = InchesToPoints(0.75)
    Selection.ParagraphFormat.FirstLineIndent = InchesToPoints(-0.75)
    Selection.WholeStory
    Selection.HomeKey Unit:=wdLine
    Selection.TypeText Text:="LITHOFACIES LEGEND"
    Selection.TypeParagraph
    Selection.TypeParagraph
    Selection.MoveUp Unit:=wdLine, Count:=2
    Selection.ParagraphFormat.Alignment = wdAlignParagraphCenter
        If ActiveWindow.View.SplitSpecial <> wdPaneNone Then
        ActiveWindow.Panes(2).Close
    End If
    If ActiveWindow.ActivePane.View.Type = wdNormalView Or ActiveWindow. _
        ActivePane.View.Type = wdOutlineView Or ActiveWindow.ActivePane.View.Type _
         = wdMasterView Then
        ActiveWindow.ActivePane.View.Type = wdPageView
    End If
    ActiveWindow.ActivePane.View.SeekView = wdSeekCurrentPageHeader
    Selection.MoveDown Unit:=wdLine, Count:=1
    Selection.TypeText Text:=vbTab
    Selection.Fields.Add Range:=Selection.Range, Type:=wdFieldPage
    ActiveWindow.ActivePane.View.SeekView = wdSeekMainDocument
    ActiveDocument.SaveAs FileName:="lithofacies", FileFormat:=wdFormatDocument, _
        LockComments:=False, Password:="", AddToRecentFiles:=True, WritePassword _
        :="", ReadOnlyRecommended:=False, EmbedTrueTypeFonts:=False, _
        SaveNativePictureFormat:=False, SaveFormsData:=False, SaveAsAOCELetter:= _
        False
End Sub
```

j. Tect_assemb_legend

```
Sub Tect_assemb_legend()
'
' Tect_assemb_legend Macro
'
    Selection.Document.Kind = wdDocumentNotSpecified
    Selection.Range.AutoFormat
    Selection.Document.Kind = wdDocumentNotSpecified
    Selection.Range.AutoFormat
    Selection.WholeStory
    Selection.Font.Name = "Palatino"
    Selection.Font.Size = 10
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    With Selection.Find
        .Text = "^t^t"
        .Replacement.Text = "^t"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
```

```
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p^t"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p^p"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p"
        .Replacement.Text = "^p^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^t"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
```

```
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "%^p"
        .Replacement.Text = "^t"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    Selection.Find.Replacement.Font.Size = 12
    With Selection.Find
        .Text = "Ω*Ω"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = True
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = True
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    Selection.Find.Replacement.Font.Size = 14
    With Selection.Find
        .Text = "Δ*Δ"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = True
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = True
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "Δ"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
```

```
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "Ω"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.ParagraphFormat.LeftIndent = InchesToPoints(0)
    Selection.ParagraphFormat.LeftIndent = InchesToPoints(0.75)
    Selection.ParagraphFormat.FirstLineIndent = InchesToPoints(-0.75)
    Selection.WholeStory
    Selection.HomeKey Unit:=wdLine
    Selection.TypeText Text:="TECTONIC ASSEMBLAGE LEGEND"
    Selection.TypeParagraph
    Selection.TypeParagraph
    Selection.MoveUp Unit:=wdLine, Count:=2
    Selection.ParagraphFormat.Alignment = wdAlignParagraphCenter
        If ActiveWindow.View.SplitSpecial <> wdPaneNone Then
        ActiveWindow.Panes(2).Close
    End If
    If ActiveWindow.ActivePane.View.Type = wdNormalView Or ActiveWindow. _
        ActivePane.View.Type = wdOutlineView Or ActiveWindow.ActivePane.View.Type _
         = wdMasterView Then
        ActiveWindow.ActivePane.View.Type = wdPageView
    End If
    ActiveWindow.ActivePane.View.SeekView = wdSeekCurrentPageHeader
    Selection.MoveDown Unit:=wdLine, Count:=1
    Selection.TypeText Text:=vbTab
    Selection.Fields.Add Range:=Selection.Range, Type:=wdFieldPage
    ActiveWindow.ActivePane.View.SeekView = wdSeekMainDocument
    ActiveDocument.SaveAs FileName:="assemblage", FileFormat:=wdFormatDocument, _
        LockComments:=False, Password:="", AddToRecentFiles:=True, WritePassword _
        :="", ReadOnlyRecommended:=False, EmbedTrueTypeFonts:=False, _
        SaveNativePictureFormat:=False, SaveFormsData:=False, SaveAsAOCELetter:= _
        False
End Sub
```

k. Referencescript

```
Sub Referencescript()
'
' Referencescript Macro
'
    Selection.WholeStory
    Selection.Font.Name = "Palatino"
    Selection.ParagraphFormat.LeftIndent = InchesToPoints(0.5)
    Selection.ParagraphFormat.FirstLineIndent = InchesToPoints(-0.5)
```

```
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    With Selection.Find
        .Text = "Ω"
        .Replacement.Text = "^p^t"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "Δ"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.MoveUp Unit:=wdLine, Count:=1
    Selection.Font.Bold = wdToggle
    Selection.Font.Size = 14
    Selection.TypeText Text:="REFERENCE LIST"
    Selection.TypeParagraph
    Selection.TypeParagraph
    Selection.MoveUp Unit:=wdLine, Count:=2
    Selection.ParagraphFormat.Alignment = wdAlignParagraphCenter

    If ActiveWindow.View.SplitSpecial <> wdPaneNone Then
        ActiveWindow.Panes(2).Close
    End If
    If ActiveWindow.ActivePane.View.Type = wdNormalView Or ActiveWindow. _
        ActivePane.View.Type = wdOutlineView Or ActiveWindow.ActivePane.View.Type _
         = wdMasterView Then
        ActiveWindow.ActivePane.View.Type = wdPageView
    End If
    ActiveWindow.ActivePane.View.SeekView = wdSeekCurrentPageHeader
    Selection.MoveDown Unit:=wdLine, Count:=1
    Selection.TypeText Text:=vbTab
    Selection.Fields.Add Range:=Selection.Range, Type:=wdFieldPage
    ActiveWindow.ActivePane.View.SeekView = wdSeekMainDocument
    ActiveDocument.SaveAs FileName:="references", FileFormat:=wdFormatDocument, _
        LockComments:=False, Password:="", AddToRecentFiles:=True, WritePassword _
        :="", ReadOnlyRecommended:=False, EmbedTrueTypeFonts:=False, _
        SaveNativePictureFormat:=False, SaveFormsData:=False, SaveAsAOCELetter:= _
        False
End Sub
```

l. Timescalescript

```
Sub Timescalescript()
'
' Timescalescript Macro
'
    Selection.Document.Kind = wdDocumentNotSpecified
    Selection.Range.AutoFormat
    Selection.Document.Kind = wdDocumentNotSpecified
    Selection.Range.AutoFormat
    Selection.WholeStory
    Selection.Font.Name = "Palatino"
    Selection.ParagraphFormat.TabStops.Add Position:=InchesToPoints(2), _
        Alignment:=wdAlignTabLeft, Leader:=wdTabLeaderSpaces
    Selection.ParagraphFormat.TabStops.Add Position:=InchesToPoints(4), _
        Alignment:=wdAlignTabLeft, Leader:=wdTabLeaderSpaces
    Selection.ParagraphFormat.TabStops.Add Position:=InchesToPoints(5), _
        Alignment:=wdAlignTabLeft, Leader:=wdTabLeaderSpaces
    If ActiveWindow.View.SplitSpecial <> wdPaneNone Then
        ActiveWindow.Panes(2).Close
    End If
    If ActiveWindow.ActivePane.View.Type = wdNormalView Or ActiveWindow. _
        ActivePane.View.Type = wdOutlineView Or ActiveWindow.ActivePane.View.Type _
         = wdMasterView Then
        ActiveWindow.ActivePane.View.Type = wdPageView
    End If
    ActiveWindow.ActivePane.View.SeekView = wdSeekCurrentPageHeader
    Selection.MoveDown Unit:=wdLine, Count:=1
    Selection.TypeText Text:=vbTab
    Selection.Fields.Add Range:=Selection.Range, Type:=wdFieldPage
    ActiveWindow.ActivePane.View.SeekView = wdSeekMainDocument
    Selection.HomeKey Unit:=wdStory
    Selection.Font.Size = 12
    Selection.TypeText Text:="Interval" & vbTab & "Rank of Interval" & vbTab & _
        "Label" & vbTab & "Base" & vbTab & "Top"
    Selection.TypeParagraph
    Selection.TypeParagraph
    Selection.HomeKey Unit:=wdStory
    Selection.Font.Size = 14
    Selection.TypeText Text:="TIME SCALE"
    Selection.TypeParagraph
    Selection.TypeParagraph
    Selection.MoveUp Unit:=wdLine, Count:=2
    Selection.ParagraphFormat.Alignment = wdAlignParagraphCenter

    ActiveDocument.SaveAs FileName:="time", FileFormat:=wdFormatDocument _
        , LockComments:=False, Password:="", AddToRecentFiles:=True, _
        WritePassword:="", ReadOnlyRecommended:=False,
EmbedTrueTypeFonts:=False, _
        SaveNativePictureFormat:=False, SaveFormsData:=False, SaveAsAOCELetter:=
_
        False
End Sub
```

m. Rocktypescript

```
Sub Rocktypescript()
```

```
'
' Rocktypescript Macro
'
    Selection.WholeStory
    Selection.Font.Name = "Palatino"
    Selection.HomeKey Unit:=wdLine
    Selection.Font.Bold = wdToggle
    Selection.Font.Size = 14
    Selection.TypeText Text:="SUMMARY ROCK-TYPE KEYWORDS"
    Selection.TypeParagraph
    Selection.TypeParagraph
    Selection.MoveUp Unit:=wdLine, Count:=2
    Selection.ParagraphFormat.Alignment = wdAlignParagraphCenter

        If ActiveWindow.View.SplitSpecial <> wdPaneNone Then
        ActiveWindow.Panes(2).Close
    End If
    If ActiveWindow.ActivePane.View.Type = wdNormalView Or ActiveWindow. _
        ActivePane.View.Type = wdOutlineView Or ActiveWindow.ActivePane.View.Type _
         = wdMasterView Then
        ActiveWindow.ActivePane.View.Type = wdPageView
    End If
    ActiveWindow.ActivePane.View.SeekView = wdSeekCurrentPageHeader
    Selection.MoveDown Unit:=wdLine, Count:=1
    Selection.TypeText Text:=vbTab
    Selection.Fields.Add Range:=Selection.Range, Type:=wdFieldPage
    ActiveWindow.ActivePane.View.SeekView = wdSeekMainDocument
    ActiveDocument.SaveAs FileName:="rock-type", FileFormat:=wdFormatDocument, _
        LockComments:=False, Password:="", AddToRecentFiles:=True, WritePassword _
        :="", ReadOnlyRecommended:=False, EmbedTrueTypeFonts:=False, _
        SaveNativePictureFormat:=False, SaveFormsData:=False, SaveAsAOCELetter:= _
        False
End Sub
```

APPENDIX 4: MICROSOFT WORD™ MACRO FOR FORMATTING EXTENDED REFERENCE LIST

The list is produced by using the 'Export All…' command, after clicking the command button 'List extended references by NTS' on the 'References: Entry form'. Open the resulting text file in Microsoft Word™ and run the macro.

```
Sub Format_refs()
'
' Format_refs Macro
'
    Selection.WholeStory
    Selection.Font.Name = "Palatino"
    Selection.Font.Size = 10
    Selection.Find.ClearFormatting
    Selection.Find.Replacement.ClearFormatting
    With Selection.Find
        .Text = "^t^t"
        .Replacement.Text = "^t"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^t^p"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p^t"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p^p"
```

```
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^p"
        .Replacement.Text = "^p^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
    With Selection.Find
        .Text = "^t"
        .Replacement.Text = "^p"
        .Forward = True
        .Wrap = wdFindContinue
        .Format = False
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
        Selection.Find.ClearFormatting
    With Selection.Find.Font
        .Bold = False
        .Italic = False
    End With
    Selection.Find.Replacement.ClearFormatting
    Selection.Find.Replacement.Font.Bold = True
    With Selection.Find
        .Text = "^p^#^#^$/^?^?^p"
        .Replacement.Text = ""
        .Forward = True
        .Wrap = wdFindContinue
        .Format = True
        .MatchCase = False
        .MatchWholeWord = False
        .MatchWildcards = False
        .MatchSoundsLike = False
        .MatchAllWordForms = False
    End With
    Selection.Find.Execute Replace:=wdReplaceAll
End Sub
```

APPENDIX 5: DATA FILE FOR GIS

On the 'Output Selection' form clicking the button, 'Export data file for GIS…', produces a number of files including a data list suitable for use as a flat-file database. The data list contains one record for each polygon, line or point representing the outcrop of a map unit in the area defined in 'Output Selection'. Each record has fifty-six fields. Fields are separated by tabs and records by carriage returns and line feeds.

LIST OF FIELDS

No. Name of Field

Polygon Keys

1. Polygon identifier

Generalized Geology Fields

2. Unit name (generalized)
3. Full label (generalized)
4. Label of dominant unit (generalized)
5. Summary rock type (generalized)
6. Age range of unit (generalized)
7. Age of the base of unit (generalized)
8. Age of the top of unit (generalized)

Detailed Geology Fields

9. Full label (detailed)
10. Label of dominant unit (detailed)
11. Summary rock type (detailed)
12. Age range of unit (detailed)
13. Age of the base of unit (detailed)
14. Age of the top of unit (detailed)
15. Supergroup
16. Group
17. Formation
18. Member
19. Sub1-unit
20. Sub2-unit
21. Sub3-unit
22. Sub4-unit

Lithofacies Fields

23. Full label (lithofacies)
24. Label of dominant unit (lithofacies)
25. Summary rock type (lithofacies)
26. Tectonic division (lithofacies)
27. Tectonic subdivision (lithofacies)

Tectonic Assemblage Fields

28. Full label (tectonic assemblage)
29. Label of dominant unit (tectonic assemblage)
30. Summary rock type (tectonic assemblage)
31. Tectonic division (tectonic assemblage)
32. Tectonic subdivision (tectonic assemblage)

Source Map Fields

33. Map ID
34. Unit ID
35. Map number
36. Publisher
37. Short-form reference
38. Scale

Ordering Number Fields

39. Generalized unit ordering number
40. Detailed unit ordering number
41. Lithofacies unit ordering number
42. Tectonic subdivision ordering number (lithofacies)
43. Tectonic assemblage ordering number
44. Tectonic subdivision ordering number (tectonic assemblage)

Colours

45. Red (generalized)
46. Green (generalized)
47. Blue (generalized)
48. Red (detailed)
49. Green (detailed)
50. Blue (detailed)
51. Red (lithofacies)
52. Green (lithofacies)
53. Blue (lithofacies)

54. Red (tectonic assemblage)
55. Green (tectonic assemblage)
56. Blue (tectonic assemblage)

DETAILED EXPLANATION OF FIELDS

Polygon Keys

1. *Polygon identifier:* This is the identifier attached to each polygon, line or point representing the outcrop of a map unit. Identifiers have the form ABxxx_yyyy, where ABxxx is the same as 'GIS ID' (e.g., NF132, *see* "Polygon Identifiers" under "Graphical Component of the GIS" and "References"), and yyyy is the same as 'Polygon ID' in the 'Polygon IDs' table. Most map units are represented by polygons and for these it is recommended that yyyy be a number from 0001 to 1999. For map units represented by lines, yyyy should be a number from 2000 to 2999. For map units depicted as points, yyyy should range from 3000 upward. In the following field explanations, polygons, lines and points that represent map units are referred to collectively as polygons.

Generalized Geology Fields

Seven variables provide names, labels, rock types and ages of units for a generalized geological map, subdivided at the highest level of the stratigraphic hierarchy, usually by supergroup, group or formation. This level of subdivision corresponds to the generalized labels and stratigraphic legend that would be produced if 'Supergroup' were chosen in the 'Select level…' field of 'Output Selection'. It matches the generalized legend that is produced at the same time as the GIS data file.

2. *Unit name (generalized):* The field contains the name of the highest ranking stratigraphic division represented in the polygon. The field is the same as the first of 'Supergroup', 'Group' or 'Formation' to have an entry in the more detailed classification (*see* fields 15 to 17). An unnamed unit is represented by its unit label, which also appears in field 4. 'Unit name' refers only to the dominant unit in the polygon (*see* fields 3 and 4 for an explanation of "dominant unit").

3 and 4. *Unit labels (generalized):* These fields contain the labels for the highest ranking stratigraphic division(s) represented in the polygon.

Most polygons on a geological map have a simple label, indicating a single unit within the polygon; for these polygons the 'Full label (generalized)' and the 'Label of dominant unit (generalized)' are the same. However, some polygons have complex labels, which list two or more unseparated units or

have added characters. For these polygons, the dominant unit is the most important unit in the polygon (e.g., eS:S) and on most maps would be used to determine the colour of the polygon; this is the unit label in field 4. The 'Full label...' (field 3) shows the complete list of unseparated units (e.g., eS:S/eS:T) and includes added characters such as question marks (*see* "Polygon labels" under "Data output").

5. *Summary rock type (generalized):* This is the phrase entered in the 'Stratigraphic units' table to describe the principal rock type in the generalized unit named in field 2.

6. *Age range of unit (generalized):* The field provides the age range of the generalized unit named in field 2 in terms of eons and eras in the Archean, eras and periods in the Proterozoic, periods and subperiods in the Paleozoic and Mesozoic, and periods and epochs in the Cenozoic. The range is based on the numerical values for the ages of the base and top of the generalized unit (fields 7 and 8) and the values entered in the 'Time scale' table.

7. *Age of the base of unit (generalized):* This is the oldest age, expressed in millions of years, that might reasonably be assigned to the base of the generalized unit named in field 2. It is the same as 'Computed lower age limit' in the 'Stratigraphic units' table. It may be derived from either radiometric or paleontological dating. Radiometric dates are adjusted for errors and paleontological dates are converted to absolute ages using the values entered in the 'Time scale' table.

8. *Age of the top of unit (generalized):* This is the youngest age that might reasonably be assigned to the top of the generalized unit named in field 2. It is the same as 'Computed upper age limit' in the 'Stratigraphic units' table.

Detailed Geology Fields

Fourteen variables provide names, labels, rock types and ages of units for a map displayed at the level of detail that was showing in the 'Select level…' field on the 'Output Selection' form when the dataset was generated. Usually this will be the 'Sub4-unit' level, producing a map with the maximum level of detail possible. This would be the same level of detail as is shown on the source maps from which the linework was digitized. The detailed geology fields match the detailed legend that is produced at the same time as the GIS data file.

9 and 10. *Unit labels (detailed):* As for the generalized units, one field shows the full label and the other shows the label for just the dominant unit. The first one or two characters indicate the age of the unit and the succeeding characters represent the stratigraphic divisions of the unit in descending

order (e.g., eS:Svf stands for "early (e) Silurian (S) Springdale Group (S) volcanic (v) felsic (f)").

Note that the generalized and detailed labels are consistent. The characters indicating age are only different if the detailed subdivision has a more restricted age range than the generalized division. The character indicating the top rank unit is always the same and the characters indicating lower rank subdivisions are simply omitted from the generalized label.

11. *Summary rock type (detailed):* This is the phrase entered in the 'Stratigraphic units' table to describe the lithology of the dominant unit in a polygon, identified by the label in field 10. Note that the description is of a unit, not of a particular polygon, so it may not be accurate for some polygons.

12. *Age range of unit (detailed):* The field provides the age range of the unit in terms of eons and eras in the Archean, eras and periods in the Proterozoic, periods and subperiods in the Paleozoic and Mesozoic, and periods and epochs in the Cenozoic. The range is based on the numerical values for the ages of the base and top of the unit (fields 13 and 14) and the values entered in the 'Time scale' table.

13. *Age of the base of unit (detailed):* This is the oldest age, expressed in millions of years, that might reasonably be assigned to the base of the unit. It is the same as 'Computed lower age limit' in the 'Stratigraphic units' table and may be derived by either radiometric or paleontological dating. In most cases, a junior unit is not dated directly and what is actually shown is the age of a more senior unit to which it belongs.

14. *Age of the top of unit (detailed):* This is the youngest age that might reasonably be assigned to the top of the unit. It is the same as 'Computed upper age limit' in the 'Stratigraphic units' table.

15 to 18. *Supergroup, Group, Formation, Member:* These four fields give the names of the stratigraphic divisions to which a unit belongs. Formal and informal names are used (*see* "Unit IDs" and "Stratigraphic Units").

19 to 22. *Sub1-unit, Sub2-unit, Sub3-unit, Sub4-unit:* These four fields are used for unnamed subdivisions below the Member level. Subunits are usually indicated by a single, lower case character, which is also used in the unit label (*see* "Unit IDs" and "Stratigraphic Units").

Lithofacies Fields

Five fields contain information from the 'Lithofacies units' table. They can be used to make a lithofacies version of the map that corresponds to the lithofacies legend that is produced with the GIS data file.

23 and 24. *Unit labels (lithofacies):* As for the generalized and detailed units, one field shows the full label and the other shows the label for just the dominant unit.

25. *Summary rock type (lithofacies):* This is the phrase entered in the 'Lithofacies units' table to describe the lithology of the dominant lithofacies unit in a polygon.

26. *Tectonic division (lithofacies):* The field contains the name of the tectonic division to which the dominant lithofacies unit belongs.

27. *Tectonic subdivision (lithofacies):* The field contains the name of the tectonic subdivision to which the dominant lithofacies unit belongs.

Tectonic Assemblage Fields

Five fields contain information from the 'Tectonic assemblages' table. They can be used to make a tectonic assemblage version of the map that corresponds to the tectonic assemblage legend that is produced with the GIS data file.

28 and 29. *Unit labels (tectonic assemblage):* As for the generalized, detailed and lithofacies units, one field shows the full label and the other shows the label for just the dominant unit.

30. *Summary rock type (tectonic assemblage):* This is the phrase entered in the 'Tectonic assemblages' table to describe the lithology of the dominant tectonic assemblage in a polygon.

31. *Tectonic division (tectonic assemblage):* The field contains the name of the tectonic division to which the dominant tectonic assemblage belongs.

32. *Tectonic subdivision (tectonic assemblage):* The field contains the name of the tectonic subdivision to which the dominant tectonic assemblage belongs.

Source Map Fields

33. *Map ID:* Each polygon has been digitized from an existing hard-copy map. This field gives the catalogue number for the map and is the same as 'Map ID' in the 'Polygon IDs' and 'References' tables.

34. *Unit ID:* The full label for the polygon as it appeared on the source map, including multiple unit labels and added characters. If an original unit has been subdivided for the purposes of entering data into *GeoLegend*, these sub-

divisions are also shown. It is useful to show the subdivisions as numbers enclosed in curly brackets (e.g., O:BLv{1} and OBLv{2}). This allows them to be easily distinguished as modifications from the source map, as published. *See* the discussion of "Unit ID" under "Polygon IDs".

35. *Map number:* The number of the source map in the publisher's map series. The field is the same as 'Map number' in the 'References' table.

36. *Publisher:* The publisher of the source map. The field is the same as 'Publisher or journal' in the 'References' table.

37. *Map reference:* The short-form reference for the source map. The field is the same as 'Short reference' in the 'References' table and matches a full reference on the list that is produced with the GIS data file.

38. *Scale:* The scale of the source map as originally published. The field is the same as 'Scale' in the 'References' tables.

Ordering Number Fields

These six fields are the same as fields 4, 10, 24, 27, 29 and 32, except that they have numeric prefixes that allow them to be sorted in a specific order. They are provided for use in GIS viewing software that creates screen legends of values in selected fields. Such software could use field 4 to make a screen legend of all the labels for generalized units. However, it would have no means of sorting the labels in a geologically sensible way. If field 39 is used instead, the numeric prefix ensures that the labels are sorted with the oldest units at the bottom of the list and the youngest ones at the top. Once the labels are sorted, the prefixes can be deleted.

39. *Generalized unit ordering number:* Equivalent to field 4. Sorting is by age and older units have higher numbers.

40. *Detailed unit ordering number:* Equivalent to field 10. Sorting is by age and older units have higher numbers.

41. *Lithofacies unit ordering number:* Equivalent to field 24. Sorting is by the user defined variables in the 'Lithofacies units' table, and the order of units matches that on the lithofacies legend.

42. *Tectonic subdivision ordering number (lithofacies):* Equivalent to field 27. Sorting is by 'Tectonic division' and 'Tectonic subdivision'.

43. *Tectonic assemblage ordering number:* Equivalent to field 29. Sorting is by the user defined variables in the 'Tectonic assemblages' table, and the order of units matches that on the tectonic assemblage legend.

44. *Tectonic subdivision ordering number (tectonic assemblage):* Equivalent to field 32. Sorting is by 'Tectonic division' and 'Tectonic subdivision'.

Colour Fields

Twelve fields contain numeric values for red, green and blue under the RGB colour system for each of the four levels of detail. RGB values are given for the generalized unit named in field 2, the detailed unit represented by a dominant label in field 10, the lithofacies unit represented by a dominant label in field 24, and the tectonic assemblage in field 29. The generalized and detailed colours are derived from the colour values entered in the 'Stratigraphic units' table, the lithofacies colours from those entered in the 'Lithofacies' table, and the tectonic assemblage colours from those entered in the 'Tectonic assemblages' table.

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