Geological Survey of Canada Bedrock Data Model and tools: design and user guide documentation including ArcGIS™ add-ins

Part 2: User Guide

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ACKNOWLEDGEMENT

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1 INTRODUCTION TO ADD-INS

An Add-In is a user-customized package for use within ArcGIS™ Desktop applications. It represents a set of tools within a compressed file type that ends in "esriaddin".

The Add-Ins described in this document were created to provide a user-friendly interface to create and edit data from a GSC Bedrock Geodatabase. **To simplify the reading of this document, the Alias** "BGDB" **is used for** "Bedrock Geodatabase".

1.1 INSTALLATION

Double-clicking on "*GSC_ProjectManager.esriAddIn*" file, stored within GSC_BedrockTools_29 folder, and clicking "Install Add-In" will complete the installation. Repeat the process for "*GSC_ProjectEditor.esriAddIn*". Make sure the version shown on screen is the most recent available from the GMF Wiki.
- *GSC_ProjectManager.esriAddIn is a set of tools designed for managing project data in ArcCatalog™.*
- *GSC_ProjectEditor.esriAddIn is a set of tools designed for editing data in ArcMap.*

When installing the Add-Ins, no administrator rights are needed and the Add-Ins can be launched by any type of user. However, these tools will only be available to the user that installs them since they are a feature of a user's own personal ArcGIS™ set up.
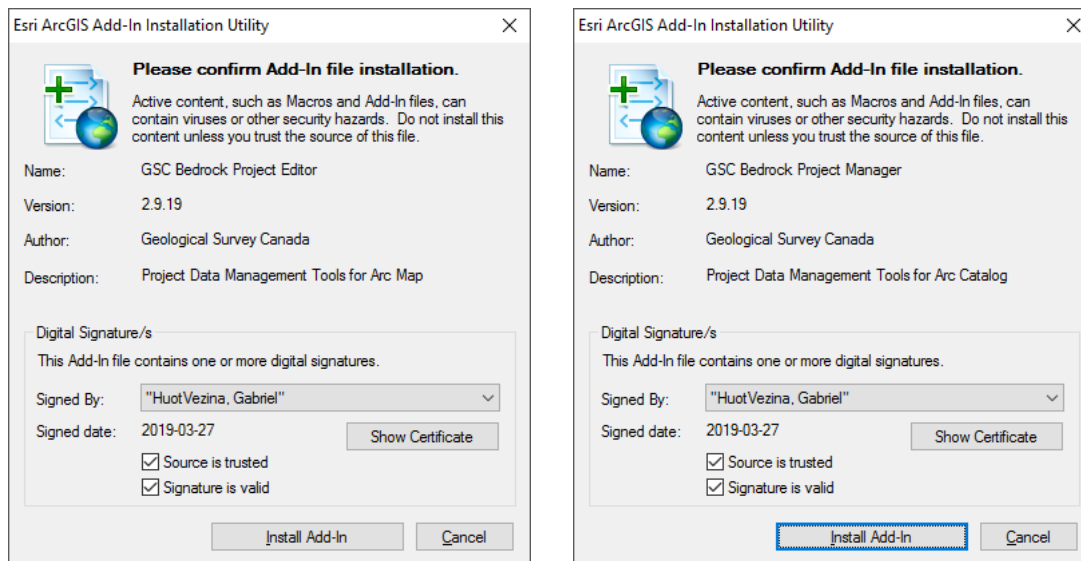
Figure 1: Add-ins installation pop-up window.

TOOLTIP: *If an add-in toolbar does not appear in the ArcCatalog™ or ArcMap™ application, open the Customize menu and open the toolbar option. Add toolbar named GIS Project Specialist when working with ArcCatalog™ or GIS Editor when working with ArcMap. Customize → Toolbar → Select wanted toolbar.*

WARNING: *Arc Catalog and Arc Map need to be closed during the install.*

1.2 COMPATIBLITY

The tools were developed on ArcGIS™ Desktop version 10.2.2 and were roughly tested in 10.3 to 10.5.

1.3 UNINSTALL

All installations can be easily removed in ArcMap™ or ArcCatalog™ by accessing the Customization menu at the top of the screen and selecting the Add-In manager option.

Customize → Add-in Manager → Delete this Add-In
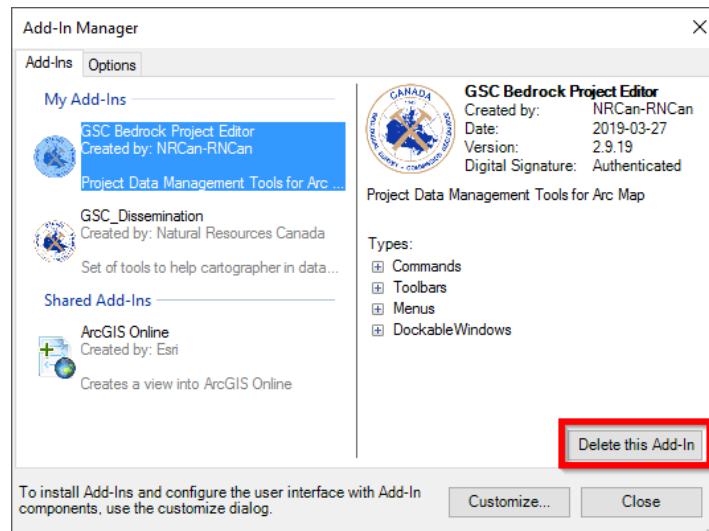
Figure 2: Uninstall of the Add-Ins.

1.4 UPDATES

Add-Ins are likely to be updated periodically with new features and bug fixes. In this case, the user should uninstall the old Add-ins before installing the new ones.

All previous settings made by the user with the "Customize" tool should still be available even after the old Add-In is deleted.

1.5 LANGUAGE

The current user guide has been written in English, but all the tools, interfaces and error messages are also available in French. To correctly set up the tools for French, please consult Section 3.1.5.

1.6 DIGITAL SIGNATURE

A digital signature can be seen on the Add-In installation window. This signature enables ArcGIS™ to recognize that the Add-In being installed comes from a trusted source. The digital signature is activated by the developer who will embed the security certificate within the Add-Ins when they are created.

Installation problems could arise if the Add-In is not signed correctly, but this should not prevent installation. Consult ESRI® help on how to change the default setting for ArcGIS™ to accept Add-Ins coming from any source, even if there's no digital signature.

http://help.arcgis.com/en/sdk/10.0/arcobjects_net/conceptualhelp/index.html#//0001000009w1000000

1.7   GENERAL WARNING

The tools presented in this guide were developed in-house by NRCan employees. Any bugs or problems should be reported to the authors. It is recommended that users read this document prior to working with the tools to better understand any limitations.

These tools were designed to assist the user in working with the Bedrock **relational geodatabase**. Typically, a relational *Geodatabase* presents a strictly-defined type of structured elements (*Feature Class* and *Tables*), all linked together by *Relationship Classes.* Even though data and information can be processed manually in this type of database without a really good knowledge of the internal structure, it is recommended to use these tools to limit possible manual errors. A relational *Geodatabase* can't be managed in the same way as a shapefile.

1.8   TEXT STYLE CONVENTION

The text style conventions used in this document are intended to facilitate understanding of the content by highlighting the various types of ArcGIS™ components listed and described in the following pages. The rules for these text style conventions are:

- Terms and components specific to the ArcCatalog™ and ArcMap™ software are shown in italics (e.g. *Geodatabase, Feature Class, Table, Addin_ArcCatalog.esriAddIn*);
- The name of a *Feature Dataset* is shown in upper case, bold (e.g. **FIELD_OBS**);
- The name of a *Feature Class* or *Table* is shown in upper case, bold/italics (e.g. ***GEO_LINES, P_SOURCE***);
- The name of an attribute is replaced by its alias and shown in upper case/lower case, bold/italics (e.g. ***StationID***, ***Report Link***);
- The title of a text box, combo box, check box or radio box within all pop-up windows is shown in upper case/lower case, italics/underline (e.g. *Select Study Area*, *Select an Organization*).

1.8.1 TERMINOLOGY CONVENTION

To avoid any confusion in the explanation of some elements associated with ArcMap™ working environment, it has been decided to use the terms "Feature Layers", "Feature Templates" and "Feature Objects", even if it diverges slightly from the typical terminology used by ESRI. Figure 3 provides context for these three terms within ArcMap™ working environment.
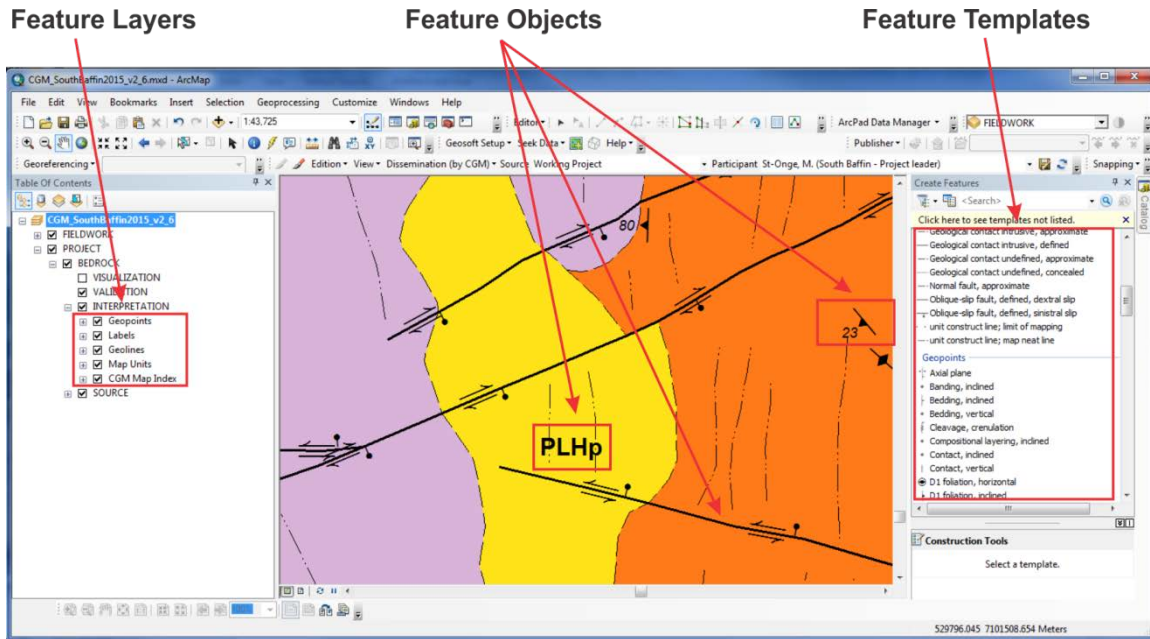
Figure 3: Context for the terminology used in ArcMap™ working environment.

2   GENERAL DESCRIPTION

This section gives an overview of the different tools belonging to either the ArcCatalog™ or the ArcMap™ Add-In. A detailed explanation of each tool will follow in Section 3. It should be noted that each of these Add-Ins include drop-down menus, where each menu contains a series of organized tools reflecting the typical workflow involved in a geological mapping project.

2.1   GSC BEDROCK PROJECT MANAGER (ARC CATALOG ADD-IN)

Tools within this Add-In are mainly used to manage the contextual information for a project, which include:

1) Setup of a working environment;

2) Basic information about a project (foundation metadata, reference sources, etc.);

3) Loading of existing data.

In general, it is the role of an information manager to create and manage this information in consultation with other project team members.

2.1.1   ENVIRONMENT MENU

This menu contains a series of tools used to set up a new working environment or to manage an existing working environment. It includes tools to create map documents (MXDs) and BGDB.
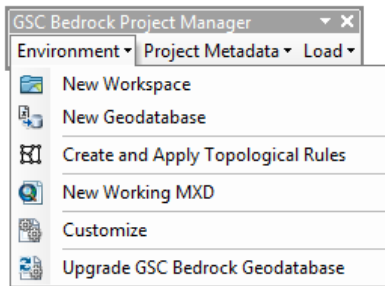
Figure 4: Set of tools available in the Environment drop-down menu.

2.1.2   PROJECT METADATA MENU

Use the Project Metadata menu to set up basic information about a project such as:

- Information on the activities and sub-activities within a project;
- Information about the organization;
- Participants and their roles in a project.
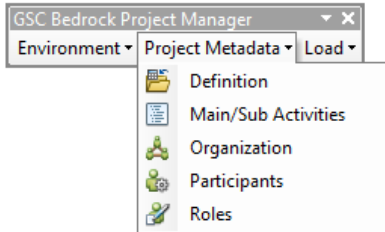
Figure 5: Set of tools available in the Project drop-down menu.

2.1.3   LOAD MENU

This menu contains all the tools needed to load data into the BGDB (e.g. field data, legacy linework, sources, study area, etc.).
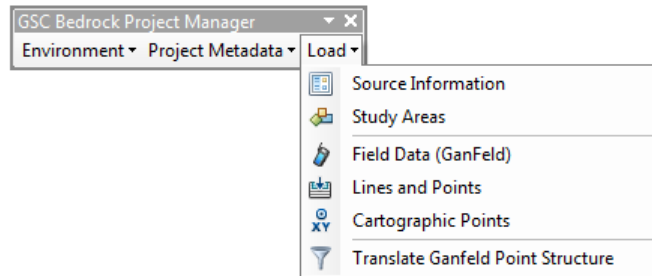
Figure 6: Set of tools available in the Load drop-down menu.

2.2   GSC BEDROCK PROJECT EDITOR (ARCMAP ADD-IN)

Tools within this add-in menu are specific to the ArcMap™ application and allow the user to create and edit project-oriented data using a customized interface that includes dockable windows, buttons and combo boxes.

2.2.1   CREATE/EDIT MENU

The Create/Edit menu contains tools that create, manage, edit and validate any data related to any active projects.
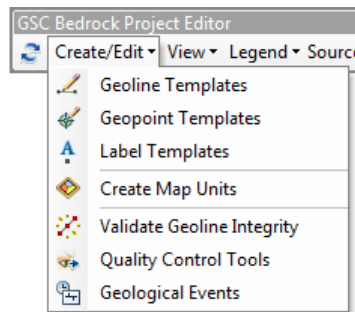
Figure 7: Set of tools available in the Create/Edit drop-down menu.

2.2.2   VIEW MENU

The View menu provides the ability to generate theme layers that facilitate the management of some of the critical elements of the Table of Contents (TOC).
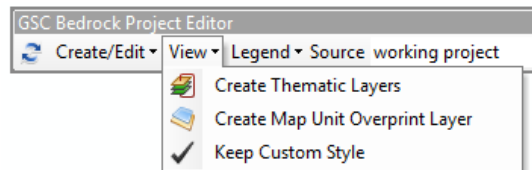
Figure 8: Set of tools available in the View drop-down menu.

2.2.3   LEGEND MENU

This menu (Figure 9) is used to prepare a legend for a whole project or a chosen map. It allows the user to configure and manage key information related to those maps. One particularly valuable tool allows creation and/or editing of the legend descriptions as well as the map surround information for each individual CGM map associated in an active project.
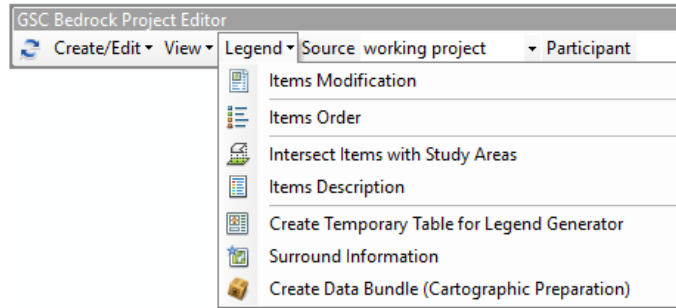
Figure 9 : Set of tools available in the Legend drop-down menu.

2.3   METADATA TOOLS

The Metadata tools allow the user to associate metadata information to any new data being digitized. These fields will be empty until populated with Project Metadata options added from the GSC Bedrock Project Manager in ArcCatalog™.
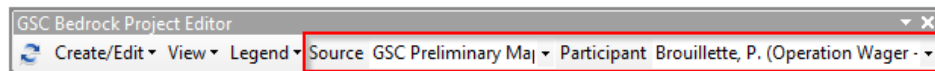
Figure 10: Metadata tools within ArcMap™ toolbar.

2.4   MAP DOCUMENT TOOLS

The Refresh button refresh on-screen symbols and their respective layers in the Table of Contents.
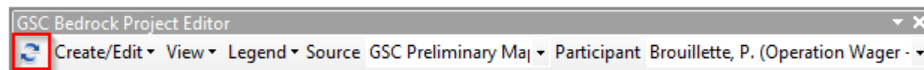
Figure 11: Map document tools within ArcMap™ toolbar.

2.5   WORKING WITH THE DATABASE AND TOOL LIMITATIONS FOR OTHER DATA

The BGDB is intended to manage the geological interpretation of any mapping project and therefore contains all the necessary features to create, edit and disseminate the geological interpretation. It is possible to load additional features, tables, rasters or other types of data, but these datasets will not be supported by the tools because they are not embedded in the BGDB model.

A best practice would be to load these non-standard datasets into a separate stand-alone *Geodatabase* in order to reduce any potential conflicts with the Project Editor tools.

Similarly, users should not try to edit Subtypes and Domain Values manually. They should consult with the IM lead of the project if edits to Subtypes or Domain Values are necessary.

3   GETTING STARTED WITH THE ARC CATALOG ADD-IN

After installing the Add-in, the user should open ArcCatalog™ to add the "GSC Bedrock Project Manager" toolbar, in order to set the working environment for all tools.

INFO: To view the Add-in in the ArcCatalog™ toolbar go to "Customize" then "Toolbars" and select "GSC Bedrock Project Manager".
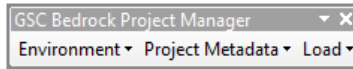
Figure 12: ArcCatalog™ Add-in toolbar.

The following sections describe all tools in more detail, focusing on the project setup process.

3.1   ENVIRONMENT DROP-DOWN MENU

Most of the tools described in this section are **required** when starting a new project. Settings available in the Environment drop-down list need to be set before the other tools will work properly. It's also under this section that the user will find the tool to re-connect to any already existing project.

3.1.1   NEW WORKSPACE

This tool creates a set of standard, organized project folders on the user PC in order to easily manage project-related data. Folders created here should be used to manage original field data, source documents, imagery documents, style files as well as the ArcMap™ working document (.mxd).

More information about style files used in the workspace can be found at section 7.

- New Workspace:
  - Enter a new project workspace name (Figure 13). Navigate to the desired location and type in a new workspace name;
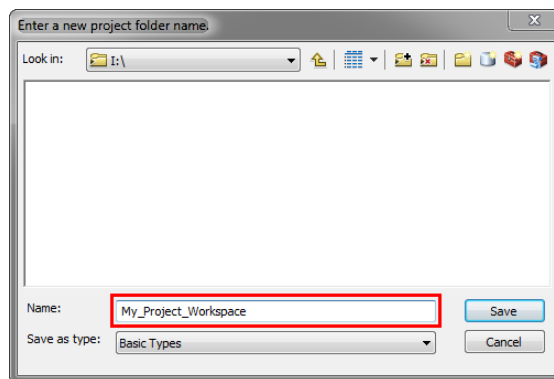
Figure 13: Set the project workspace location.

o   A folder with the project workspace name is created at the location specified by the user.
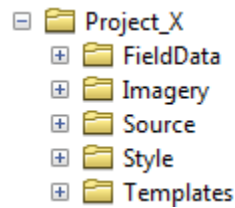
Figure 14: Typical ArcCatalog™ folder structure.

⚠ *WARNING: to connect to an existing workspace, go to "Customize" in the Environment drop-down.*

⚠ *WARNING: The Source folder is used as a repository for all source data related to a project, regardless of the format (shapefile, pdf, image, etc.).*

3.1.2   NEW GEODATABASE

To create a new BGDB:

1. Click on the New Geodatabase tool.
2. Navigate to the Tools4Project folder.
3. Select the XML master project template (GSC_BEDROCKGDB_SCHEMA_V2_9.xml).

The template is needed to create the new *Geodatabase* with all the *Tables*, *Features Classes* and other information about the new project. This newly created BGDB is stored under the project folder previously created in step 3.1.1.
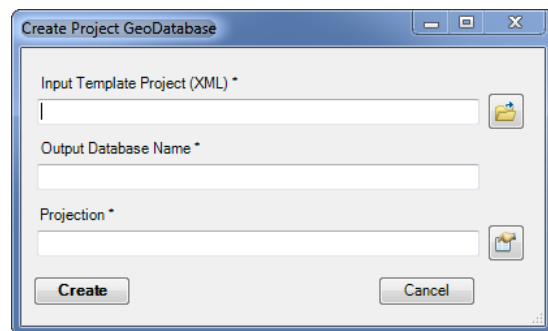
Figure 15: Create BGDB main window.

1. Select the XML master file (GSC_BEDROCKGDB_SCHEMA_V2_9.xml), from the GSC_BedrockTools_29 folder.
2. Type in the new database name.
3. Select the projection that will be applied to all *Feature Classes* of this new BGDB.

ⓘ *INFO: see document "GSC Bedrock Geodatabase Data Model" for more information about the schema.*

✓ *TOOLTIP: Use an underscore symbol "_" instead of spaces in database names to prevent undesired errors while using the tools.*

⚠ *WARNING: A proper workspace folder must already exist before creating a new BGDB. Use the New Workspace tool described in Section 3.1.1 or set the current workspace as shown in Section (3.1.5).*

⚠ *WARNING: Selecting a geographic spatial reference could lead to problems with spatial resolution since a broad geographic reference, like WGS84, doesn't have the same spatial grid resolution as a projected one. **It is recommended that a projected spatial reference be used for an accuracy lower than 100 meters, for example, UTM or Albers.***

3.1.3 CREATE AND APPLY TOPOLOGY RULES

This tool will create a set of topological rules (GEO_TOPO) in the project feature dataset named **GEO**. By doing so, a topology validation also is simultaneously triggered if data already exist in the BGDB. Topology rules provide a mechanism to perform integrity checks on your data and help to validate and maintain better feature representations in your geodatabase.

The tool will apply the following set of topological rules to the **GEO_LINES** *Feature Class*:
- Must not overlap (other lines);
- Must not have dangles;
- Must not self-overlap;
- Must not self-intersect;
- Must be single part.

⚠ *WARNING: This tool needs to be run on any new database.*

3.1.4 NEW WORKING MXD

This tool will create a working MXD project file based on the active working BGDB. The MXD project is organised to display an optimised hierarchical set of *Layers* intended to facilitate the viewing experience. The MXD file is created at the same location as the BGDB.

By default, the MXD map document is given the same name as the BGDB. If a document with the same name already exists, a letter will be added to the end. Running this tool four consecutive times would result in the creation of these four new documents:

- Melville.mxd
- Melville_A.mxd
- Melville_B.mxd
- Melville_C.mxd

The template used to create the project map document is found in the workspace sub folder "Templates". This subfolder contains an empty map document that can be customized by the user if they need a particular pre-set configuration available whenever a new project map document is created with the tool. For example, the scale could be set as fixed to 1:50 000 in the template map document. Any newly created document will have a fixed scale of 1:50 000 and will also contain all of the project data and hierarchy mentioned above.

Figure 16 shows an example of the hierarchical nature of ArcMap™ layers in the TOC of the BGDB.
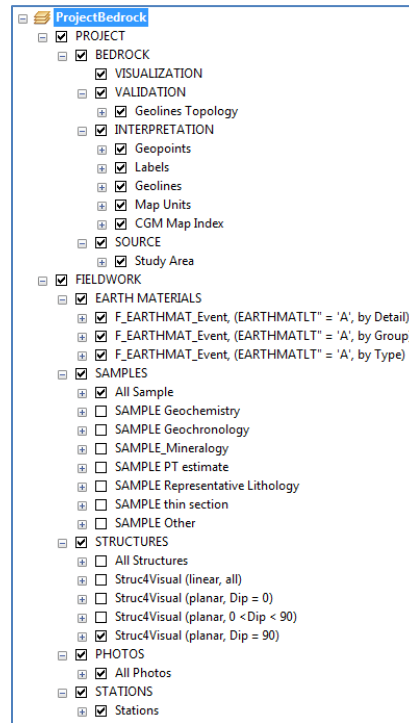
Figure 16: Hierarchical layers in the Table of Contents of a typical Bedrock Project.

The layers are organized in the TOC in two *Group Layers* named PROJECT and FIELDWORK. In the PROJECT *Group Layers* of a typical bedrock mapping project, four other *Group Layers* contains all necessary layers needed to manage the following themes: VISUALIZATION, VALIDATION, INTERPRETATION and SOURCE (Figure 16). Additional explanations of these themes appear in Section 4. The FIELDWORK *Group Layers* contains field data provided by the field data collection system (i.e. GanFeld or GSC Field Application). Since these layers are mostly related to *Tables* in the BGDB, they are represented here by an ESRI® proprietary feature type called "*Events*".

More information about *Events* can be found on ESRI's website:
http://resources.arcgis.com/en/help/main/10.1/index.html#//00s50000001z000000

INFO: A user can rename the map documents at any time without any consequences to the tools.

TOOLTIP: If you are creating a new mxd for a project that already has data, use the Refresh Symbols icon on the GSC Bedrock Project Editor toolbar in ArcMap™ Add-in to render and symbolize the existing data properly.

TOOLTIP: Following a BGDB update, the user should run this tool to create a new mxd in which the source paths are connected to the upgraded GSC Bedrock Geodatabase.

TOOLTIP: The project workspace folder contains a "Templates" sub folder which contains an ArcMap™ template that is used to create the project map document. This document can be modified to suit project needs. The 'New Working MXD' tool uses this template to build the project

mxd. For example, if some default layers are required to be in all created mxds, adding these default layers to the template will ensure they will be added to all newly created MXDs.

WARNING: When selecting the 'New Working MXD' button, the tool will automatically start running in the background. The user should wait for the pop-up message "Process completed." before clicking anywhere on the screen.
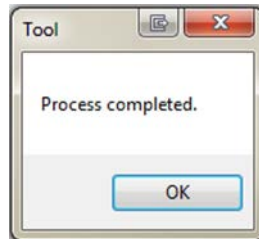
Figure 17: Process completed pop-up message

3.1.5 CUSTOMIZE (OPTIONAL)

This optional tool shown in Figure 19 can be used to switch to another workspace location and/or BGDB.

Some additional parameters are available to set the project language, scale and the type of report.

With this tool, the user can connect to either an active workspace and/or an active database. They don't need to be in the same location, so each can be configured separately.

Parameter information:

- **Customize**
  - *Select a Workspace*: Available list of current workspace(s) on the user's computer. Select one for quick access or click the green plus sign to add a new workspace to the list.
  - *Select a Working Database*: Available list of current BGDBs on the user's computer. Select one for quick access or click on the green plus sign to add a new database to the list.
  - *Language*: Select English or French as the language for the current project.
  - *Project Scale*: If the scale of the project is known, type it into the text box.
  - *Map Scale*: If the scale of a current working map is known, type it into the text box.

Figure 18: Set working environment form.

  - *Report type:* Choose a proper report file type. For example, reports are produced for quality control of data attributes. List of invalid or unconventional values are then available and easy to check with reports.

Figure 19: Working Environment form.

    TOOLTIP: The current workspace and database are marked as active in parentheses within the drop-down list.

    TOOLTIP: By selecting French as the language, all the menus within the add-ins will be in French.

    WARNING: If the selected workspace wasn't created using the project tools, some BGDB tools may not function because subfolder names do not match those created within the tools.

3.1.6 UPGRADE GSC BEDROCK GEODATABASE

This tool upgrades the BGDB by saving a copy of the original database, then creates an empty one and then loads all data from the original copy. Within the tool, the user selects the database to upgrade, enters a new name for it and then selects the latest data model schema (XML file). By default, the upgraded version will have the same projection as the original database.
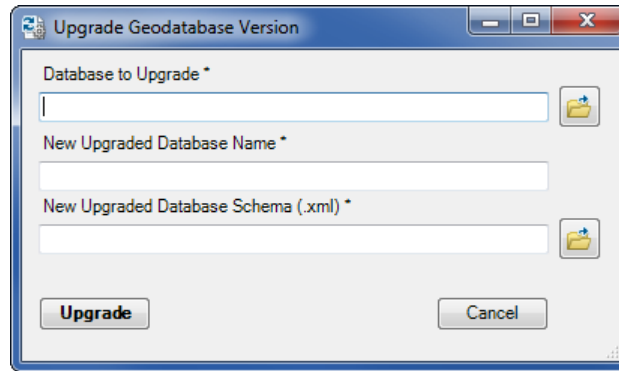
Figure 20: Upgrade geodatabase tool interface.

TOOLTIP: This tool doesn't delete the original BGDB. Using it will result in one copy of the original BGDB plus an upgraded one, both in the same location within the project workspace folder.

WARNING: Running this tool won't copy the topological layer, so the user will need to recreate it with the proper tool (Section 3.1.3).

WARNING: Running this tool will make the project mxd document outdated. The user must then run "New Working MXD"(Section 3.1.4).

3.2 PROJECT METADATA DROP-DOWN MENU

The project drop-down menu contains a series of tools designed to define the metadata at the project level. Some of these metadata are required information for a project while, others are mandatory when digitizing. As shown in Figure 21, the tools are organized in order to reflect their order of use (i.e. a participant must exist before a role is assigned).
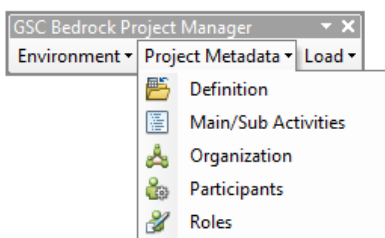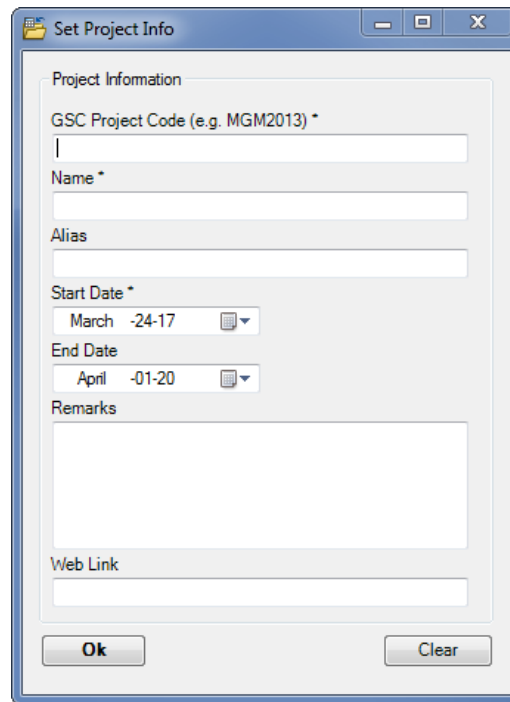
Figure 21: List of tools available to create Project Metadata.

3.2.1 DEFINITION (STEP 1)

This tool is used to enter high level information on a project (metadata).

Figure 22: Main project information form.

The Project Code and Project Name fields are mandatory because the code is used as a unique identifier for the database and the name is used by various tool interfaces. Generally a project code is needed, but if one doesn't exist, the code can be the same as the project name.

✅ *TOOLTIP: To quickly change a date, click on the upper month/year display and navigate to the appropriate date (*Figure 23*).*
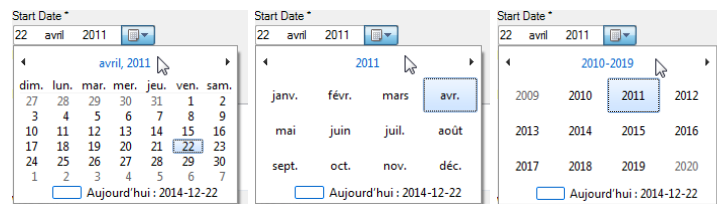
Figure 23: Edit date within the calendar tool.

⚠️ WARNING*: Fields followed by an asterisk are mandatory*.

3.2.2 MAIN AND SUB ACTIVITIES (STEP 2)

This tool is used to add a main activity within the current project or a sub activity within a selected main activity. A project can have more than one main activity and a main activity can have multiple sub activities. The user must make sure that the appropriate _Activity Type_ is selected prior to entering data in this form.

For example, a project encompassing Hudson and Ungava Bay might include several main exploration activities (e.g. Core Zone, Secondary Zone, etc.) as part of the larger project study area. Within one of these main activities, yearly field mapping work (e.g. Field 2014, Field 2015, etc.) would represent sub-activities.

⚠ _WARNING: A Canadian Geoscience Map is always considered as a sub-activity. When defining a map as a sub-activity, the user should check the "CGM Map" box (see example in Figure 24 right)._
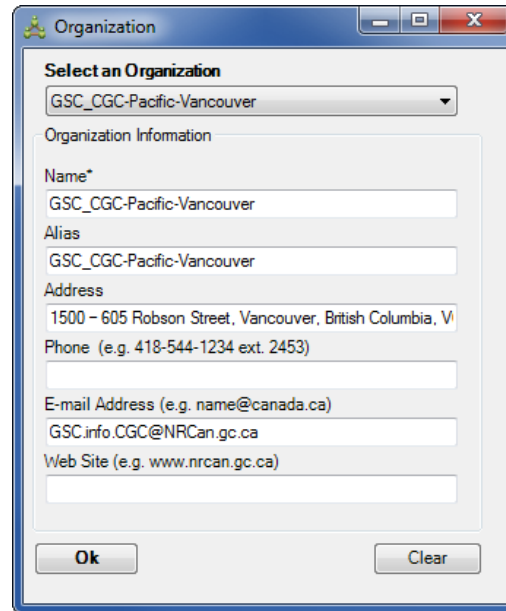
⚠ _WARNING: When the CGM Map box is selected, a default keyword 'Build_CGM_' is added to the Name box. This keyword is necessary for various tools. The user must simply enter a number (it could be an assigned PPI number or some random one) at the end of the keyword without removing any characters (see example below). The Alias text box should be used to enter the map name._

Figure 24: Main and sub activity form (left). Example of a CGM Map as a sub-activity where the interface changes slightly.

3.2.3 ORGANIZATION (STEP 3)

This tool manages a list of organizations that are related to the current project. A default list of all GSC's Division offices is provided with the database, but the user can add to this as needed.

Figure 25: Manage Organization form.

3.2.4 PARTICIPANTS (STEP 4)

This tool allows the user to add new participants or to modify information about existing participants in the current project. It is strongly recommended new participants are added as shown in Figure 26, because the *Login* and *Alias* entries may be used later in the GMF workflow.

Figure 26: Manage Participant form.

✔ *TOOLTIP: If a user has entered a new organization and it isn't available within this form, use the "Clear" button to update the whole window with the latest information.*

✔ *TOOLTIP: Alias will be used throughout the various tools.*

✔ *TOOLTIP: In this case Alias will be used to store the creator and the editor respectively in the CREATORID and EDITORID fields of the feature classes when editing in ArcMap™. This alias information is used as identification for any participant on a project.*

3.2.5 ROLES (STEP 5)

With this tool, the user can assign each participant to an existing main or sub activity with an assignment role. Note that a participant can be assigned multiple roles within the same activity.

All the information gathered here is used as project level metadata as well as core metadata when digitizing new information within ArcMap™.

Figure 27: Assign Participant Roles form.

3.3 LOAD DROP-DOWN MENU

This next menu offers tools used to upload various types of data within the BGDB or a project workspace.
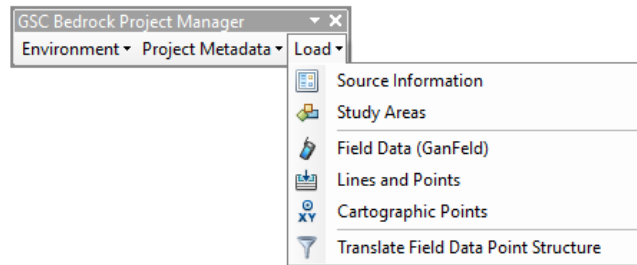
Figure 28: List of tools available for loading data.

3.3.1 SOURCE INFORMATION

This tool is intended for users to manage all relevant reference documents and use them as linked sources. Source documents are managed as tabular information stored in a table named **P_SOURCE**, and can also be related to a polygon geometry stored in **STUDY_AREA**. The Source Dataset and Study Areas tools provide all the necessary parameters to facilitate such management.

The Source Dataset tool prompts the user to add a new source or edit an existing one. As shown by the example in Figure 29, a PDF file of Open File 1839 is being added by the user and all mandatory fields are being filled. The complete citation of the source is also entered in the *Full Citation* field. The user may also check the *Copy Source File to Current Project* option checkbox resulting in the tool physically copying the added source document to the source sub-folder within the project workspace folder.

Figure 29: Add Source Dataset form.

✔ *TOOLTIP: The* Alias *name will be displayed in the ArcMap™ Add-in allowing the user to select a proper source while digitizing.*

✔ *TOOLTIP: Double-clicking within the* Full Citation *and* Remarks *text boxes will open a larger window to view and edit the entire entry.*
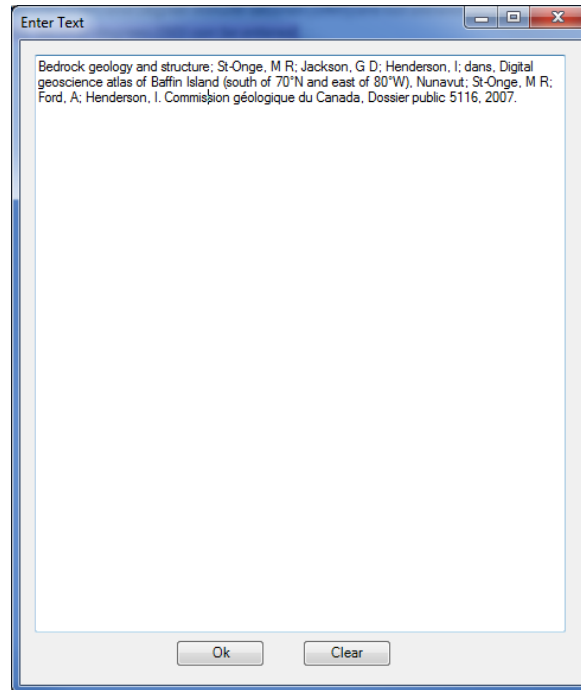
Figure 30: Typical larger text entry window.

3.3.2 STUDY AREAS

The *Study Areas* tool has a broad spectrum of use. As mentioned above, this tool allows the user to relate a spatial geometry to previously entered references, but it also provide facilities to relate or assign a spatial geometry to any main or sub-activity in the BGDB. The user is invited to read Chapter 2.2.6 of the "GSC Bedrock Geodatabase: Model Design and Description" for further explanation on the study area concept.

The user must first select the *Purpose* of the new study area. Available purposes are:

- Project area;
- Main activity area;
- Sub activity area;
- Source area.

Based on the selected *Purpose*, the *Purpose Value* text box will display a picklist with related main activities, sub-activities or sources already stored in the BGDB.

A study area *Name* and *Remarks* can be added for further information in ArcMap™.

To assign a spatial geometry, two options are offered. The first option is to enter the bounding box coordinates of the area using the same coordinate system as defined when creating the BGDB. The second option

is to Import an existing polygon *Feature*. Clicking the import button will enable the user to navigate to and select a shapefile or *Feature Class* in which the polygon will be retrieved and added to the BGDB. Either option will result in the addition of a new polygon to the **STUDY_AREA** Feature Class.
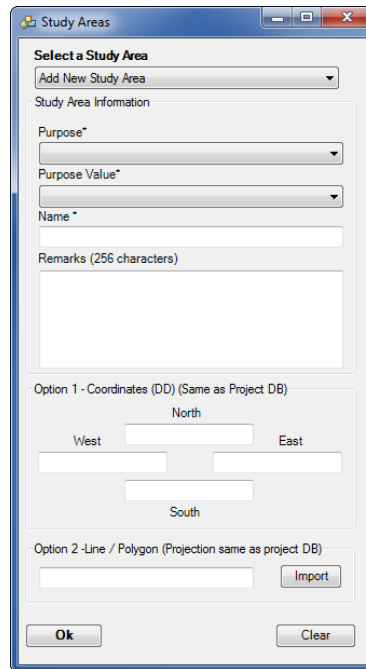
Figure 31: Define Study Area form.

✔ *TOOLTIP: When using Option 2, if the user selects a line feature, it will automatically be converted to a polygon.*

⚠ *WARNING: When importing an existing feature, if more than one polygon or line exists inside it, they will all be imported and added to the project. It is recommended to import only one feature at a time.*

⚠ *WARNING: Degree-minutes (DM) and Degree-minute-seconds (DMS) are not allowed as manual entry coordinates. Only decimal degrees (DD) can be entered.*

⚠ *WARNING: CGM borders (neatline) should come from the cartographer and not a topographic sheet neatline. The later will result in small gaps between the CGM data and the cartographic border of the map surround.*

3.3.3 FIELD DATA (GANFELD)

This tool is used to append GanFeld field data. The GanFeld source dataset can be either a folder containing the typical set of Shapefiles **or** a Field Geodatabase. The tool does not have any other parameters that need to be set by the user.
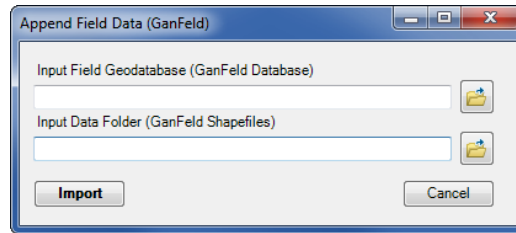
Figure 32: Append Field Data form.

3.3.4 LINES AND POINTS

This tool is designed to load or append to the active BGDB external lines and points dataset (usually referred to as 'legacy data').

The user is prompted to **Select Data Type: point** *or* **lines**, then navigate to an input shapefile or feature class and selects the appropriate ID field to be used as the **GeolineID** or the **GeopointID**. The ID numbers are unique feature identifiers for each type of **GEO_LINES** or **GEO_POINTS** and need to be assigned by the user prior to the load or append process. A complete list of IDs with their respective description is available in **SYMBOL_GEOLINE** and **SYMBOL_GEOPOINT** tables.
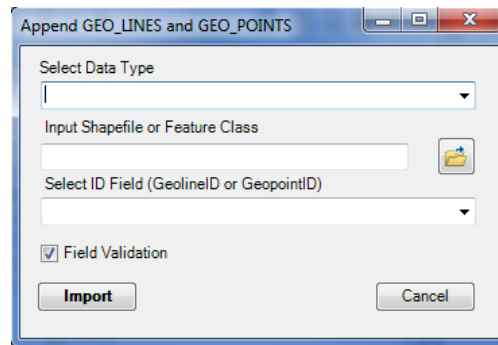
Figure 33: Append GEO_LINES and GEO_POINTS form.

When appending /loading data, the user may either check or uncheck the *Field Validation* box. If the validation box is checked, the tool looks for the **GeolineID** or **GeopointID** field, and then breaks down and parses the coded values into the appropriate fields. For example, the result generated by the tool on a **GeolineID** = 101002029999 is:

- o **GEOLINETYPE** = 10 (contact)
- o **QUALIFIER** = 1002 (depositional-conformable)
- o **CONFIDENCE** = 02 (approximate)
- o **ATTITUDE** = 99 (not applicable)
- o **GENERATION** = 99 (not applicable)

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By selecting the check option, no other fields will be appended/loaded.

If the Field Validation option is not checked, no validation is performed and all data will be appended/loaded even if the input values are incompatible with the domain values. The latter could result in incorrect rendering when using other tools.

In choosing this option, the user should ensure the data is correct and compatible with the domain values.

> ✔ *TOOLTIP: Newly added lines and points are automatically made available in ArcMap™ as templates and symbols in an editing session.*

> ✔ *TOOLTIP: To append existing symbol codes coming from the original data, add a new field "GSC_SYMBOL" to the feature class and the code will be appended by this tool.*

> ⚠ *WARNING: The ID field requires a valid GeolineID or GeopointID value for each feature record. For example, each feature must have a GEOLINEID code from the SYMBOL_GEOLINE table:*

GEOLINEID	Legend_Description
101001019999	contact; depositional, defined
101001029999	contact; depositional, approximate
101001039999	contact; depositional, inferred
101001049999	contact; depositional, concealed
101002019999	contact; depositional-conformable, defined
101002029999	contact; depositional-conformable, approximate
101002039999	contact; depositional-conformable, inferred

3.3.5   CARTOGRAPHIC POINTS

This tool has a wide array of use cases. It can be used to upload into the database, any external points that are not managed by the model or the tools, e.g. geochronology or fossils. As an option, the user can select a predefined set of themes to upload the points into or even add new ones.

The first pop-up window (Figure 34) will request the input point file, which can be either a GIS file or a non GIS format like Excel worksheets. For the latter type of data, the next window will ask for coordinate fields to convert them into a valid point feature class.
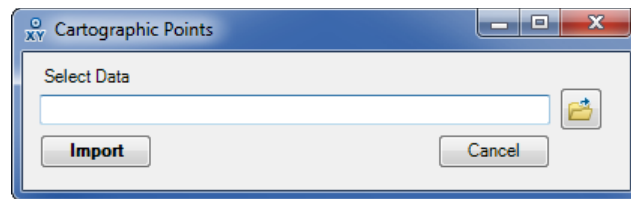
Figure 34: First pop-up window to select point data to import.

The managed types of files are listed below.
- Shapefiles (.shp)
- Feature classes
  - File Geodatabase (.gdb)
  - Personal Geodatabase (.mdb)
- Tables
  - File Geodatabase (.gdb)
  - Personal Geodatabase (.mdb)
  - Database File (.dbf)
- Text files

- o Comma Separated Value (.csv)
- o Text (.txt)
  - Tab key separated values ("\t")
  - Comma Separated values (",")
  - Semi-colon separated values (";")
- Excel Files
  - o Office 1997 (.xls)
  - o Office 2010 and higher (.xlsx)

After selecting input point data, a second window will appear in which user can enter other information, such as a list of additional fields, source, scale, etc. Figure 35 shows a typical interface, in which a theme like Geochronology or Drill Holes can be selected. The green cross ➕ is used to add new themes to the default list.
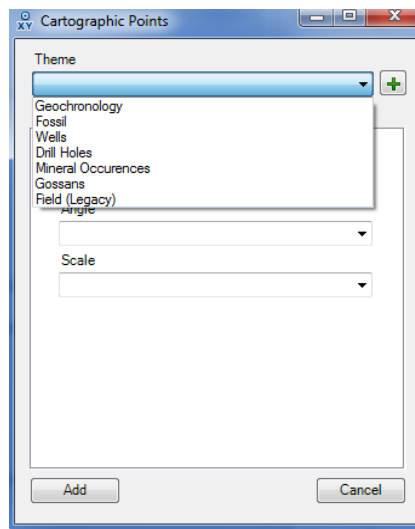
Figure 35: Second window of Cartographic Points menu to define more information about the point data, before uploading into the database.

The first tab (*GIS*) (Figure 36), will be available if the entered data isn't of a GIS type and will be used to define X and Y coordinates.

The second tab, for *Cartographic Information*, can be used to define symbols, symbol angle and also their scale for viewing purposes.
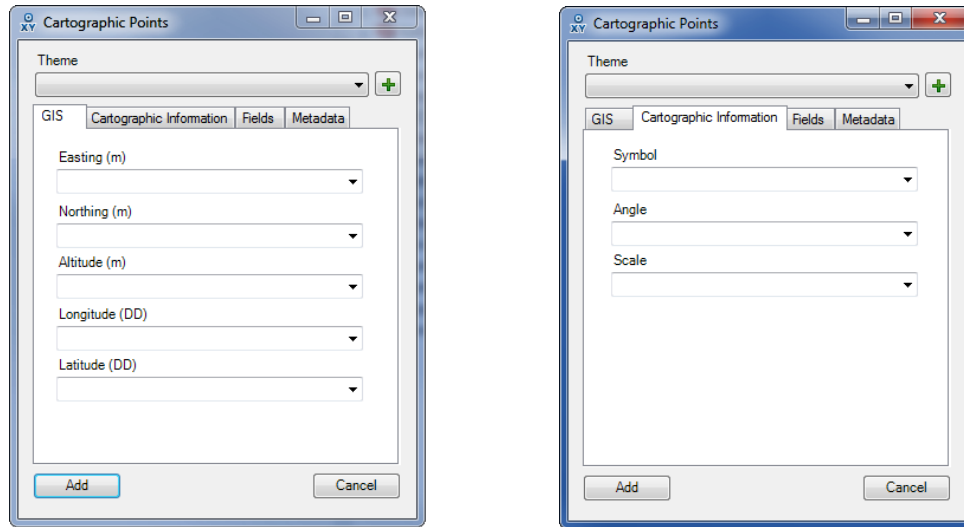
Figure 36: First tab of Cartographic Points to import non spatial file (txt, csv and Excel files) and second tab to import information for representation.

In Figure 37, the third tab (*Fields*), is used to select a subset of fields to upload. Alternatively, all populated fields can be added into the database by selecting the 'Keep All Field' option.

Finally, the *Metadata* tab can be used to select a pre-defined source from database to relate the entered data.
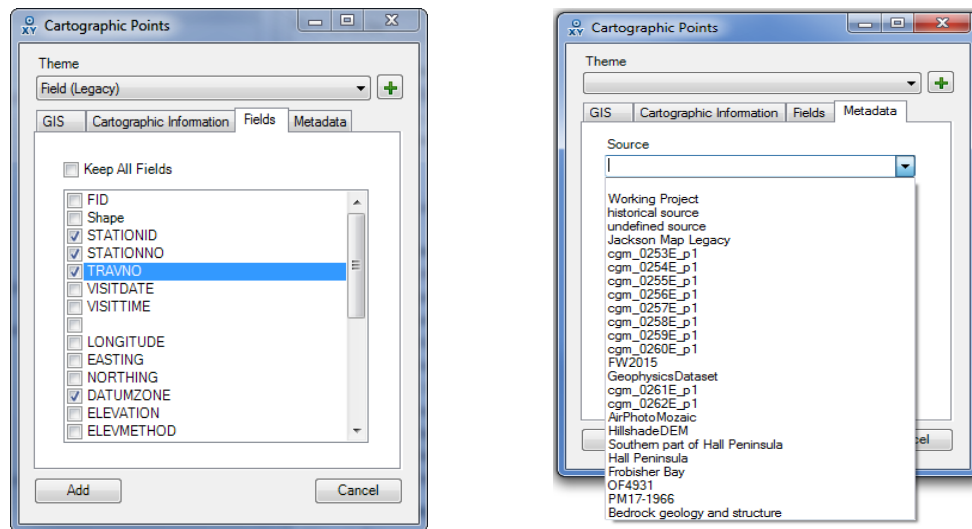
Figure 37: Using the Fields tab to select a subset of fields and assigning source Metadata to the new features.

The output will be uploaded inside a feature class named **CARTOGRAPHIC_POINT**. It will only hold information useful for the point and its related symbols. All other information will be stored in a new table

named **CARTOGRAPHIC_***SelectedTheme*. For example, in Figure 37 Fields tab, a new table named **CARTO-GRAPHIC_FIELDLEGACY, will be created with the** selected fields. If the option "Keep All Fields" had been checked, all fields would be kept.

3.3.6 TRANSLATE FIELD DATA POINT STRUCTURE

In a BGDB, the structural measurements acquired with either Arc Pad custom plugging Ganfeld or Windows 10 GSC Field App can be stored inside **GEO_POINTS** *Feature Class*. In order to plot these measurements on the map with adequate symbology, the user must select the data from a **F_STRUC (Ganfeld) table or F_STRUCTURE (GSC Field App).**

Based on the values entered for each structural measurement in the **input** table, the tool will automatically create the appropriate *GeopointID* and fill in the required fields. Also, the tool will automatically detect proper data type from one of the two home build field data gathering applications.
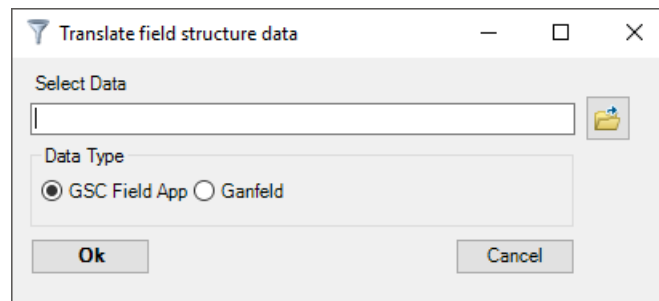
Figure 38 Pop-up window to select structure data to translate into GEO_POINTS.

The tool is compatible with GSC Field App data format (.sqlite) and Ganfeld shapefiles (.shp), file geodata-base (.gdb) or personal geodatabase (.mdb).

A text file is made available for any points that couldn't be translated and transferred to **GEO_POINTS**. This validation text file is created within the project workspace folder and is named "AppendStrucFromGan-FeldErrors.txt". Entries in this file represent problematic *STRUCIDs* within a field(s) due to invalid or missing values in the source data and as a result, aren't accurately translated into the appropriate science language of the BGDB. The records will still be loaded into the **GEO_POINTS** *Feature Class* but with an invalid *Geo-pointID*. The user will then have to make appropriate corrections manually.

✓ *TOOLTIP: The user doesn't have to assign ID numbers (***GeolineID*** or ***Geopoints ID***) prior to load/ap-pend field data. The tool assigns the appropriate ID's based on the values stored in table ***F_STRUC***.*

⚠ *WARNING: The SENSE field will be truncated if there are more than 50 characters. This is true for GanFeld data prior to version 2014 and for GSC Field App data.*

⚠ *WARNING: The RELATED field will be truncated if there are more than 15 characters. This is true for GSC Field App data.*

⚠ *WARNING A validation text file will be created within the Project workspace folder if any input points weren't transferred due to errors from the source GanFeld data.*

4 GETTING STARTED WITH ARCMAP™ ADD-IN

When ArcMap™ opens, the user will see a new toolbar named GSC Bedrock Project Editor (Figure 39). If the toolbar is not visible and the Add-in has been properly installed, the user should go to the ArcMap™ toolbar and select: Customize→ Toolbar → GSC Bedrock Project Editor.

Figure 39: ArcMap™ Add-in.

Prior to using the Add-in, two major steps must have been done using the appropriate tools from the ArcCatalog™ toolbar: Create/Setup the working environment and Create a working MXD. To use the tools, an edit session must be started within ArcMap™. If the working environment parameters are not properly set, a WARNING message will pop up (Figure 40) asking to set the current layers as active. If the current dataset comes from a valid project geodatabase and working environment, by selecting 'Yes', it will be activated and can be used by the tools.
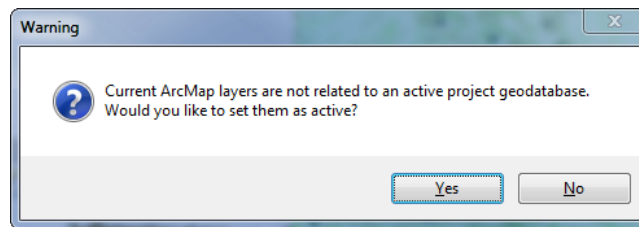
Figure 40: Typical error message generated by inadequate working environment setup.

INFO: To view the Add-in in the ArcMap™ toolbar, right-click on the toolbar and select "GSC Bedrock Project Editor".

4.1 CREATE/EDIT MENU

Tools within this menu are grouped under four different categories:

1. Create/edit geological interpretation;
2. Generate map unit polygons from interpretation;
3. Validation/quality control;
4. Create/edit legend item age.

The above processes are part of the "building a geological interpretation" workflow to produce geological maps. The following sections describe each of the tools involved in these processes.

4.1.1 GEOLINE TEMPLATES

As defined by ESRI: *"….Creating features is accomplished through the use of feature templates. Feature templates define all the information required to create a feature: the layer where a feature will be stored, the attributes a feature is created with, and the default tool used to create that feature. Templates also have a name, description, and tags that can help you find and organize them. If*
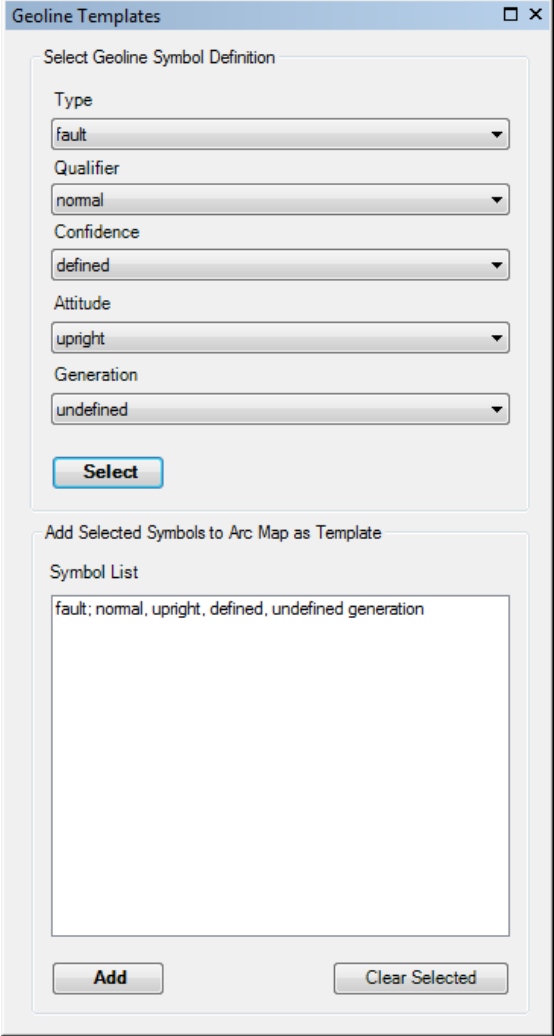
templates are not present when you start editing, they are automatically created for each layer in the current editing workspace…" (ArcGIS Resources)

The use of a template is therefore unavoidable when digitizing new features, but their creation is greatly facilitated by the tools presented here. They overcome complex and tedious steps involved when using the default tool "Create New Template" in ArcMap™.

The Geoline Templates tool enables the user to create a customized template using a dockable window as shown in Figure 41. The five dropdown lists guide the user through the creation of a Geoline. The *Select* button adds the newly-created Geoline to the *Symbol List*. When all Geolines are selected, the *Add* button updates the ArcMap™ feature template and the user is now ready to start digitizing.

The user must be aware that creating a new template is not automatically reflected by an update on the Table of Contents. The Table of Contents is refreshed following these three steps:

1- Create new template (as explained above);
2- Digitize at least one object with the newly created template;
3- Click the Refresh button on the Map Document Tool 🖫 🔁 (see Section 2.4).

Figure 41: Geoline template dockable window.

ℹ️ *INFO: Geological terminology displayed by this tool is controlled by the BGDB table SYMBOL_GEOLINES.*

✔️ *TOOLTIP: Once the templates are created using this tool, all information is stored in the BGDB. Thus, they remain accessible to the user even if the ArcMap™ feature templates are deleted or the feature layer symbology is removed.*

✔️ *TOOLTIP: A default symbol value is associated with each type of template created with this tool (table SYMBOL_GEOLINES). This default symbol value can be changed afterward by using the Legend Item tool (see Section 4.3.1).*

4.1.2 GEOPOINT TEMPLATES

The Geopoint Templates tool enables the user to create a customized template using a dockable window as shown in Figure 42. The six drop-down lists guide the user through the creation of a Geopoint, and the _Select_ button adds the newly-selected Geopoints to the _Symbol List_. When all Geopoints are selected, the _Add_ button updates the ArcMap™ feature template and the user is now ready to start digitizing.

The user must be aware that creating a new template is not automatically reflected by an update on the Table of Contents. The Table of Contents is refreshed following these three steps:

1- Create new template (as explained above);
2- Digitize at least one object with the newly created template;
3- Click the Refresh button on the Map Document ⟳ Tool (see Section 2.4).

(i) INFO: _Geological terminology displayed by this tool is controlled by the BGDB table_ **SYMBOL_GEOPOINTS**.

✔ TOOLTIP: _Once the templates are created using this tool, all information is stored in the BGDB. Thus, they remain accessible to the user even if the ArcMap™ feature templates are deleted or the feature layer symbology is removed._

✔ TOOLTIP: _A default symbol value is associated with each type of template created (see table_ **SYMBOL_GEOPOINTS**). _This default symbol value can be changed afterward by using the Legend Item tool (see Section 4.3.1)._
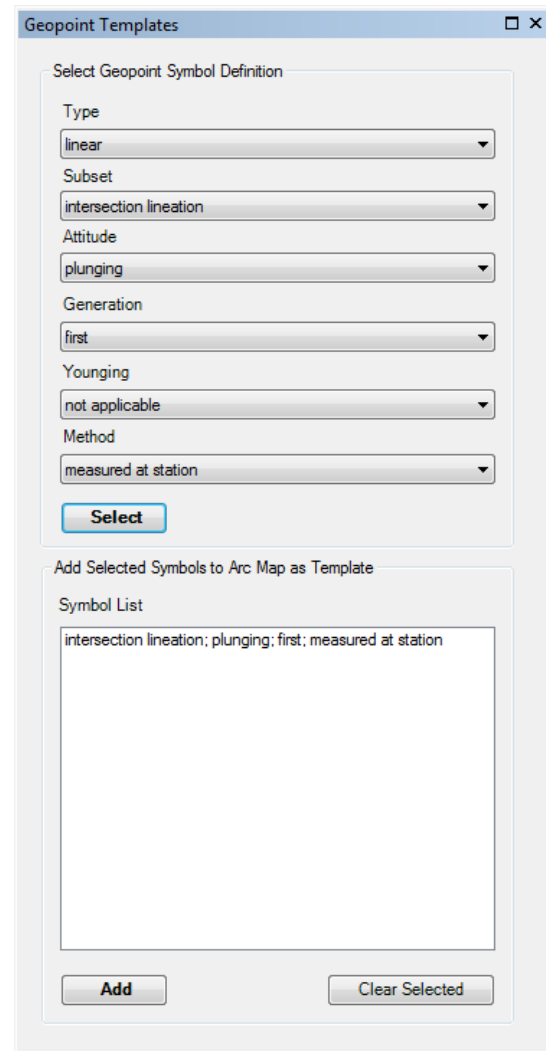
Figure 42: Geopoint template dockable window.

4.1.3   LABEL TEMPLATES

The Label Template tool is used to create new labels. Generally, the user creates a label that acts as the alias (or annotation) of a map unit, which is then displayed on screen when digitizing new label points. The tool also provides an option to symbolize the label with colour. Clicking the rainbow fan (Figure 43) opens a style selector window in which the user can select an appropriate map unit colour from a predefined colour style. It is also possible to add an age prefix that will be added automatically as a prefix to the label. For example, using the Age Prefix drop-down list and selecting Archean, the label will be preceded with "Ar".

Complete descriptions and final map annotation text can be entered with a tool named Legend Items (see Section 4.3.4).

In the case of a label used to create overprint map units (e.g. Quaternary deposits on bedrock), the user must select the _Is Overprint?_ checkbox (Figure 43). When this option is selected, a pop-up box requires the overprint be assigned a level (1-5) indicating the draw order for multiple overprints. For more information on overprints, consult Section 4.1.4 for a discussion of map unit creation.
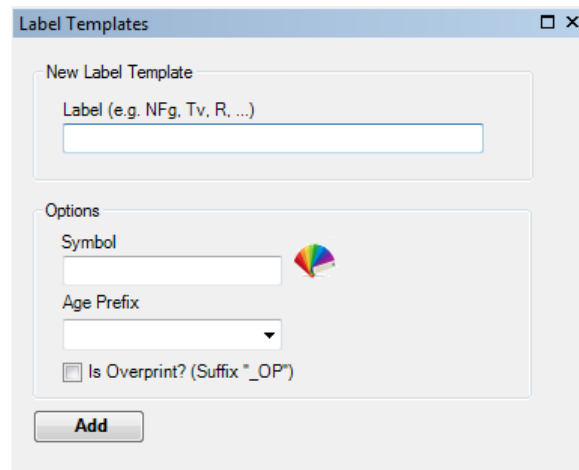
Figure 43: Label manager dockable window.
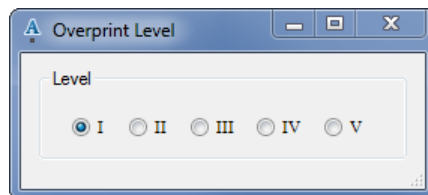
Figure 44: Overprint Level pop-up window.

The ArcMap™ feature template is built using the Geoline, Geopoint and Label templates. As shown on Figure 45, the _Create Features_ dockable window is automatically updated every time a new template is added.
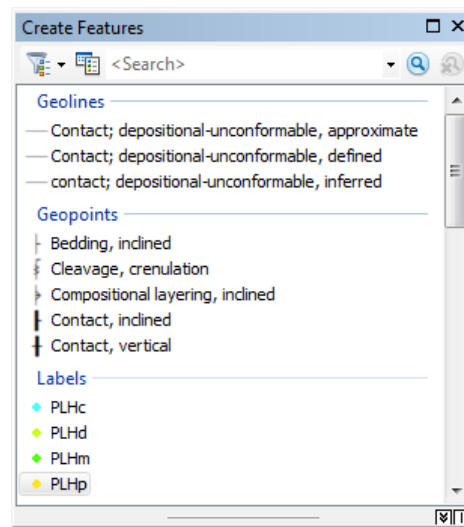
Figure 45: Create Features dockable window.

✓ *TOOLTIP: Label colours selected here are used to symbolize the map units.*

⚠ *WARNING: The ArcGIS™ Object Loader cannot be used here. Creating a label involves a complex process of updates in the BGDB that is not supported by the Object Loader geoprocessing tool.*

4.1.4 CREATE MAP UNITS (NO INTERFACE)

This tool builds a new map unit feature class (**GEO_POLYS**) from existing lines and labels. The three steps that build map unit polygons are:

1. Map unit polygons are built from all Geolines having the field **IsBoundary** set to "yes";
2. A map unit's colour is inherited from that assigned to the label in the Label Template. If no colour has been assigned to the label, the resulting polygons will be colourless;
3. Overprint polygons are created at the end of the process ensuring that they appear on top of the map units, within the same layer.

✓ *TOOLTIP: To modify the default value of **IsBoundary**, double-click on the relevant template to access its properties (Figure 46). Locate the "Is Boundary" field and select an available option in the drop-down list. All the new lines will have a default value to "Is Boundary".*

✓ *TOOLTIP: To create overprints above one another, make sure that the overlapping parts contain all the required labels. For example, in the case where part of map unit A has mineral alteration, which is also beneath a gossan, there should be labels for the overprint units where they overlap with map unit A.*

✓ *TOOLTIP: Refer to Section 4.1.6.2.3 Validate "Is Boundary" (Geoline), for how to quickly view the status of a Geolines boundary (i.e. whether the **'IsBoundary' is** set to "yes").*

TOOLTIP: To ensure the Create Map Units tool works properly, refer to the tools available within the Quality Control menu.

WARNING: There are many reasons why map unit polygons will not display on-screen: the absence of labels, topology errors within the Geolines, labels copied from a different MXD project, etc. The Topology Validation Tool (see Section 4.1.6.4) can quickly find polygons missing labels.

Figure 46: ArcMap™ Template Properties form.

4.1.5   VALIDATE GEOLINE INTEGRITY (NO INTERFACE)

This tool validates the internal geometry of the Geolines.

List of operations done by this tool:

- Deletes empty geometry (length = 0);
- Explodes multiple part lines to single part;
- Removes any Bezier curves inside the geometry.

When confronted with a Bezier line, the tool converts it to a proper polyline object in which a series of vertices define the path from the start to the end. Instead of having a formula defining the bend between start and end point of the line, the tool will add vertices based on the pre-set project scale (see Section 3.1.5). If no scale has been pre-set for the current project, the default XY resolution of the project spatial reference will be used. If the XY resolution is used, the number of vertices in each line could be very high,

since the default resolution of a NAD 83 Zone 16 projection is 0.0001, resulting in vertices added every 0.0001 meter. This represents a higher degree of accuracy than is necessary. The formula below demonstrates the resolution (*R*) that will be used to calculate the distance between the new introduced vertices. Variable *S* is the project scale.

$$R = 2\left(\frac{S}{10\,000}\right)$$

<div align="center">**Equation 1: Formula to calculate resolution.**</div>

For example, the minimal distance between new vertices will be 10 meters if the project scale is set to 1:50 000.

4.1.6 QUALITY CONTROL

This tool will validate the data in the model (Figure 47). Most of the options starting with "Validate" or "Find" create a special query layer within a Table of Contents group layer named VALIDATION. These query layers allow the user to quickly see any potential problems arising from inadequate geometry or erroneous data entry in some crucial fields of the original feature (e.g. ***IsBoundary***). These quality control tools DO NOT make any adjustment/correction to the original features; they only highlight errors that require appropriate corrective editing by the user. The only tool that performs an automatic correction is *"Apply Null Values for Empty Attributes".*

The user must be aware that the data displayed in the query layers is the same as the original feature class used by the validation tools. However, the symbology is slightly altered (colour, line thickness, etc.) in order to highlight the result of the validation query.

Options within the *Quality Control* tool are grouped by Attributes versus Geometry. Tools in grey text are currently not implemented but one planned.

✓ TOOLTIP: Output query layers are made available inside the ArcMap™ Table of Contents group layer named VALIDATION.
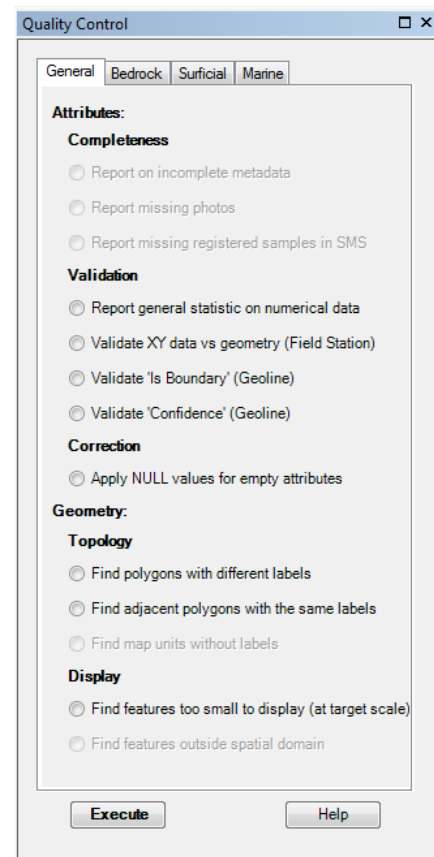
Figure 47: Quality Control main dockable window.
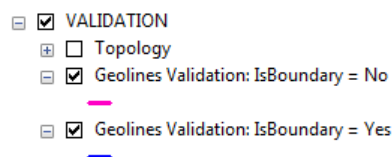
<div align="center">**Figure 48: Example of an output "Validate Is Boundary" query layer within ArcMap™ Table of Contents.**</div>

TOOLTIP: Any query layer can be removed from the ArcMap™ Table of Contents at any time. They are automatically recreated each time the Quality Control tools are run.

4.1.6.1   ATTRIBUTES - COMPLETENESS

4.1.6.1.1   REPORT ON INCOMPLETE METADATA

Will check specific metadata that are mandatory and give a list of incomplete fields.

NOT IMPLEMENTED YET.

4.1.6.1.2   REPORT ON MISSING PHOTOS

NOT IMPLEMENTED YET.

4.1.6.1.3   REPORT ON MISSING REGISTERED SAMPLES IN SMS

NOT IMPLEMENTED YET.

4.1.6.2   ATTRIBUTES – VALIDATION

4.1.6.2.1   REPORT GENERAL STATISTIC ON NUMERICAL DATA

This validation option will output a report in which a listing of all the numerical fields inside the project database are listed and given with a set of statistics from all the values of this particular field (Figure 49). The described statistics are listed below.

- Minimum
- Maximum
- Average
- Standard Deviation
- Value Count
    - The number shown in the "Count" field doesn't include "<null>" values, so it may be different from one field to another within the same dataset.

The dataset name containing the numerical fields and field alias are also available in the report.

Dataset Name	Field	Minimum	Maximum	Average	Std. Dev.	Count
	TraverseNo	207	207	207	0	1
	Shape_Length	653.8341	653.8341	653.83	0	1
GEO_EVENT						
	AGEMIN_VALUE	<null>	<null>	NaN	NaN	0
	AGEMAX_VALUE	<null>	<null>	NaN	NaN	0
	AGEMAX_CERTAINTY	<null>	<null>	NaN	NaN	0
	AGEMIN_CERTAINTY	<null>	<null>	NaN	NaN	0
GEO_LINES						
	Shape_Length	31.6925	305338.5538	3045.45	9186.09	9168
GEO_POINTS						
	Azimuth	0	360	227.49	91.41	1514
	DipPlunge	0	90	47.19	21.72	1474

Figure 49: Example of a report on General Numerical Field Statistics.

Report file type can be chosen by the user and changed using the "Report" option in the "Customize" tool. If nothing was selected during the initial setup, the default report file type will be a pdf file saved at the root of user's workspace folder.

TOOLTIP: Any user can modify the report template. It is found inside the workspace sub folder named "Templates" as an ".rlf" file named "QCReport_NumericalData".

4.1.6.2.2 VALIDATE XY DATA VS GEOMETRY

This validation tool performs a check between the geometry of all spatial objects in **F_STATION** against the coordinate values stored within the attribute table. This check is made because the attributes easting/northing and latitude/longitude are not dynamically bound to the spatial geometry of the associated objects in **F_STATION**. As an example changing a northing value in the attribute table does not automatically update the position of the corresponding point in **F_STATION**.

Validation results are available within the « VALIDATION » group layer, as two new layers named:

- Field Station Validation: Easting/Northing Mismatch (red points);
- Field Station Validation: Latitude/Longitude Mismatch (red points).

TOOLTIP: Geographic coordinates are validated within 4 decimals.

TOOLTIP: Projected coordinates are validated within 2 decimals.

4.1.6.2.3 VALIDATE "IS BOUNDARY" (GEOLINE).

This validation tool creates two new query layers based on the value stored in the attribute field *IsBoundary* of the *Feature Class* **GEO_LINE**. This tool is helpful in finding all contacts that are used to create polygons.

Validation results are available within the « VALIDATION » group layer, as two new layers named:

- Geoline Validation: IsBoundary = Yes (blue lines);
- Geoline Validation: IsBoundary = No (pink lines).

4.1.6.2.4 VALIDATE "CONFIDENCE"

This validation tool creates five new query layers based on the value stored in the attribute field **Confidence** of the *Feature Class* **GEO_LINE**.

Validation results are available within the « VALIDATION » group layer, as five new layers named:

- Geoline Validation: Confidence = Defined (green lines);
- Geoline Validation: Confidence = Approximate (yellow lines);
- Geoline Validation: Confidence = Inferred (orange lines);
- Geoline Validation: Confidence = Concealed (grey lines);
- Geoline Validation: Confidence = Not Applicable (red lines).

4.1.6.3 ATTRIBUTES – CORRECTION

4.1.6.3.1 APPLY NULL VALUES FOR EMPTY ATTRIBUTES

This tool is intended to apply "<Null>" values within empty cells in all tables and features. Any blank cells or single space used within the cells are replaced with the ESRI null value ("<Null>").

⚠️ *A dataset should not typically contain 'zeros' to refer to empty cells. An exception would be for strike and dip measurements where '0' represents a valid numerical value.*

4.1.6.4 GEOMETRY – TOPOLOGY

4.1.6.4.1 FIND POLYGON WITH DIFFERENT LABELS

This validation tool highlights polygons with label errors. The tool creates two new query layers, one showing the problematic polygons and the other showing the conflicting associated labels.

Validation results are available within the « VALIDATION » group layer as two new layers named:

- Map Unit Validation: Contains different labels (red outline with pink fill);
- Label Validation: Conflicting labels within the same map unit (red points).

4.1.6.4.2 FIND ADJACENT POLYGONS WITH THE SAME LABEL

This validation tool is used to quickly find adjacent polygons having the same label. If two adjacent polygons have the same label, they should either be made into one larger polygon or one of the labels be changed to a different map unit.

Validation results are available within the « VALIDATION » group layer as one new layer named:

- Map Unit Validation: Adjacent polygons (red outline with pink fill).

4.1.6.4.3 FIND MAP UNITS WITH NO LABELS

This tool is intended to find map units with missing labels.

Validation results are available within the « VALIDATION » group layer as one new layer named:

- Map Unit Validation: Contains no labels (yellow lines).

4.1.6.5 GEOMETRY – DISPLAY

4.1.6.5.1 FIND FEATURES TOO SMALL TO DISPLAY (AT TARGET SCALE)

This tool highlights polygons (i.e. map units) that are too small to be visible on a paper map at a fixed scale. This tool searches for polygons which, at a given scale, have a length below 1 mm and others with a length between 1 - 1.5 mm. These key length sizes were previously defined by GeoScaler tools used to generalize geological maps (Huot-Vézina, G. *et al.* 2012). Prior to using this tool, the user must have set the scale of the intended map(s) using the "Customize" tool in the ArcCatalog™ Add-in.

This tool can also be used to find very small polygons resulting from errors when digitizing (ex. sliver, knots, and loops). These small polygons are usually devoid of any label and will be highlighted on-screen and made available for correction.

Validation results are available within the « VALIDATION » group layer as three new layers named:

- Map Unit Validation: Small features (Between 1 and 1.5 mm on paper map) (yellow outline and filling);
- Map Unit Validation: Small features (Less than 1 mm on paper map) (orange outline and yellow filling);
- Map Unit Validation: Small features without any labels, (Less than 1.5mm on the paper map) (red outline and yellow filling).

4.1.6.5.2 FIND FEATURE OUT OF SPATIAL DOMAIN

✖ *NOT IMPLEMENTED YET.*

4.1.6.6 BEDROCK / GEOMETRY – ANALYZE

This set of validation tools is specific to bedrock mapping projects.

4.1.6.6.1 VALIDATE FAULT MOVEMENT

This tool highlights conflicts between faults and their movement based on the selected symbols. The prerequisites for using this tool are:

- The *GeoLineType* value in **Geoline** feature Class must be "Fault";
- Field *HangWallDirection* in **Geoline** must be filled with value other than "Not Applicable" or "Undefined";
- Symbol code must start with "2.02".

Validation checks the consistency between the symbol used and the bearing of the fault movement stored in *HangWallDirection*. In most cases, this inconsistency is due to the start/end points used to digitize a line (i.e. direction of digitalization). Flipping the line usually solves the problem.

Validation results are available within the « VALIDATION » group layer as eleven new layers named:

Figure 50: Bedrock Tab from the Quality Control dockable window.

- Inconsistencies between digitized symbol and the value in *HangWallDirection* (red lines):
    - Geoline Validation: Hangwall value should be flipped;
    - Geoline Validation: Hangwall code value should be N side down (01);
    - Geoline Validation: Hangwall code value should be NE side down (02);
    - Geoline Validation: Hangwall code value should be E side down (03);
    - Geoline Validation: Hangwall code value should be SE side down (04);
    - Geoline Validation: Hangwall code value should be S side down (05);
    - Geoline Validation: Hangwall code value should be SW side down (06);
    - Geoline Validation: Hangwall code value should be W side down (07);
    - Geoline Validation: Hangwall code value should be NW side down (08).
- Invalid value in *HangWallDirection* or invalid Symbol code (yellow lines):
    - Geoline Validation: Movement is either « Undefined » or « Not Applicable »;
    - Geoline Validation: Verify symbol code.

4.1.6.6.2 VALIDATE CONTACT VS GEOLOGICAL AGE

This tool highlights contact lines delimiting polygons of different ages (based on the legend order). The value of this tool is in finding unconformable line type contacts that can then be uniquely symbolized.

Validation results are available within the « VALIDATION » group layer as two new layers named:

- Geoline Validation: Contact vs Age = Must be flip (yellow lines);
- Geoline Validation: Contact vs Age = No neighbors or Undefined Legend Order (red lines).

4.1.6.7 SURFICIAL / ATTRIBUTES – CORRECTION

4.1.6.7.1 APPLY NULL IN GEO_LABELS (CASE: NO SECOND UNIT)

❌ *NOT IMPLEMENTED YET.*

4.1.6.8 SURFICIAL / GEOMETRY – ANALYZE

4.1.6.8.1 VALIDATE DRUMLIN LOCATION

❌ *NOT IMPLEMENTED YET.*

4.1.6.8.2 VALIDATE REGIONAL FLOW DIRECTION

❌ *NOT IMPLEMENTED YET.*

4.1.6.9 MARINE

❌ *NOT IMPLEMENTED YET.*
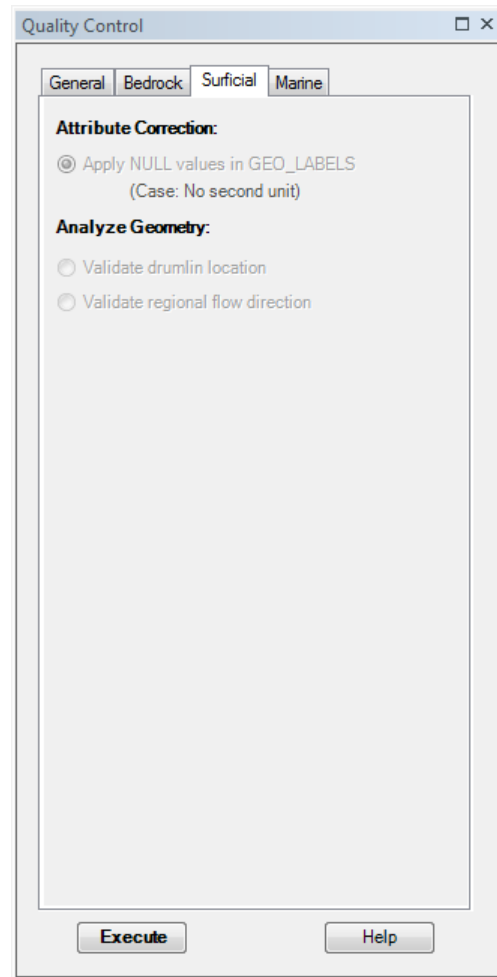
Figure 51: Quality Control for Surficial.

4.1.7   GEOLOGICAL EVENTS

A new table dedicated only for ages that can be associated to items like Geolines and Map Units. With this new tool, a user can create a new geological event that will then be associated with a selected list of items. Those items can be either generic like a map unit or from an on-screen selection of elements. For example, an organic matter map unit could be associated with a Quaternary event.

Ages, in millions of years, can also be set with a certainty value if needed.
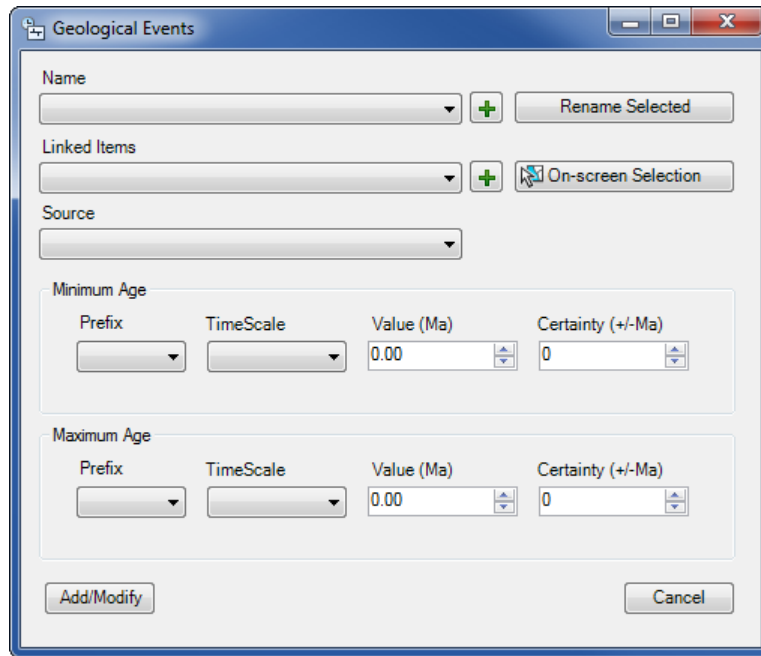
Figure 52: Geological Events tool interface.

The Name drop-down list can be used to select an existing event for modification purposes. The green cross opens a pop-up window to enter a new event name that will then be appended to the name list. The rename button can be used if an event name needs to be changed.

Once the geological event is created or selected, a user can set a list of items that will be associated to it with the linked items drop-down list. If there are no items already selected for the event, the green cross can be used to select generic items or the "On-Screen Selection" button to associate the event with Geolines or Map Unit specific elements from their respective layers. Items will then show the Object ID (OID) field value in parentheses beside their generic name (Figure 53).
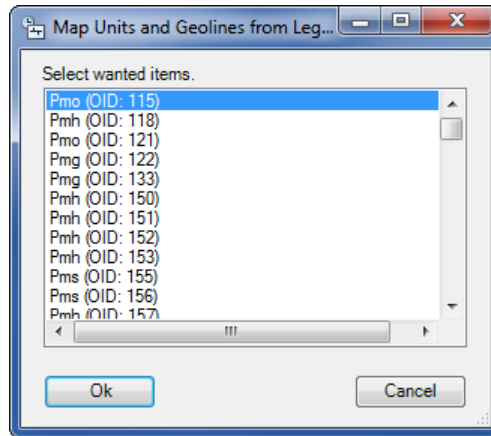
Figure 53: Example of an "On-screen selection" option of map units.

A source can also be associated to an event, if that is available.

Finally, options are available for setting the minimum and maximum age values for an event. Timescale and prefixes (e.g. early, middle, and late) are available as drop-down lists. The timescale presents relative ages (e.g. Quaternary, Mesozoic etc.) but absolute age values (Ma) and their associated certainty can also be added.

4.2   VIEW

4.2.1   CREATE THEMATIC LAYERS (FROM SELECTED LAYER)

In ArcMap, the Table of Contents lists all the layers on the map and shows what the features in each layer represent. Specifically, it shows a complete list of all features loaded on the map with their assigned symbology. This tool provides the ability to generate theme layers for the selected layers Geolines or Geopoints based on their *Subtypes*.

The following figures are good examples of the default structure of the Table of Contents for Geolines (Figure 54) and the structure generated by the use of this tool (Figure 55). All theme layers are available under the « VISUALIZATION » group layer.

☐ ☑ Geolines
    — <all other values>
    Legend Description
  — fault; thrust, approximate, undefined generation
  — fold; neutral, approximate, second generation
  –· fault; motion undefined, inferred, undefined generation
  — fold; neutral, approximate, fourth generation
  — fault; motion undefined, defined, undefined generation
  — fold; synform, overturned, approximate, second generation
  — thin lithology; dyke, defined, undefined generation

  — fold; synform, upright, approximate, second generation

  — structural lineament; motion undefined, approximate, undefined ge
  — fold; neutral, approximate, third generation
  — thin lithology; dyke, inferred, undefined generation
  — fold; antiform, overturned, approximate, second generation

  — fold; antiform, upright, approximate, second generation

  — fold; neutral, approximate, first generation
  — trace; bedding form line
  — fault; motion undefined, approximate, undefined generation
  — thin lithology; dyke, approximate, undefined generation
  –– fault; thrust, inferred, undefined generation
  — fault; thrust, defined, undefined generation

  — fold; antiform, approximate, second generation

  — fold; synform, approximate, second generation

  — fold; antiform, approximate, third generation
  — fold; synform, approximate, third generation
  –· contact; depositional, inferred
  — unit construct line; other, see remarks
  — contact; depositional, approximate
  — contact; depositional, defined
  — contact; faulted, defined
  · unit construct line; limit of mapping
  — fault; normal, defined, undefined generation
  — fault; normal, approximate, undefined generation
  — contact; facies change, approximate

Figure 54: Default Geoline layer symbolization

☐ ☑ Geolines - contact
    FGDC_SYMBOL, GEOLINEID
    Legend Description
  — contact; depositional, defined
  — contact; depositional, approximate
  –· contact; depositional, inferred
  — contact; faulted, defined
  — contact; facies change, approximate
⊞ ☑ Geolines - fault
  ☑ Geolines - shear
⊞ ☑ Geolines - structural lineament
⊞ ☑ Geolines - fold
⊞ ☑ Geolines - thin lithology
⊞ ☑ Geolines - unit construct line
⊞ ☑ Geolines - trace
  ☑ Geolines - limit
  ☑ Geolines - overprint
  ☑ Geolines - isograde

Figure 55: Layers structure for Geoline after using the tool.

✔ *TOOLTIP: This tool also works with data, not related to a BGDB, as long as the feature has subtypes.*

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4.2.2   CREATE MAP UNIT OVERPRINT LAYER

This tool provides the ability to generate two theme layers from the layer Map Units. The first layer displays all polygons identified as "Overprint" while the second layer displays the typical map unit polygons. This gives flexibility to the user to turn them on and off as needed. These theme layers are available under the « VIZUALIZATION » group layer.

4.2.3   KEEP CUSTOM STYLE

This tool will give user the chance to keep his own way of stylizing the layers while doing digitization and others edits. Sometime, while working over aerial pictures or satellite data, having black symbols might not be efficient. Bright colors are often use to make a good contrast with the background. By clicking this tool, a user will prevent the refresh button to change back all layers items to their project associated style and will keep user choice of colors and font sizes, while also adding newly added symbols.

Unselecting the tool will make it stop and the refresh button will again synchronize layers item with their project related symbols.

4.3   LEGEND

The next set of tools was developed primarily to facilitate the production of CGM geological maps by automating some crucial steps such as the preparation of a legend and the management of surrounding elements. For most users, the main interest resides in the ability to manage numerous legends within one database.

4.3.1   ITEMS MODIFICATION

The items modifications tool must be used to perform any type of editing on the project legend. The types of editing targeted here are:

1. Changing the colour of a label (e.g. map unit);
2. Modifying the description displayed in the feature template and feature layer for any type of Geoline, Geopoint or Label;
3. Changing a Label name, etc.

The interface of the current version of this tool is shown in Figure 56.

Main set of button and options

- *Type*: select a type from the drop-down list (Geoline, Geopoint, Map Unit, Header, etc.). Use the green cross to add new theme inside the list.
- *Items*: select an item from the drop-down list already stored in the Legend Generator for the selected item type.
- *Reset Interface*: this button resets to the default settings the Item modifications dockable window.
- *Modify*: this button applies all edits.
- *Delete*: remove the selected item from the Legend Generator table.

✔ *TOOLTIP: Removing an item from a project (e.g. D1 thrust fault, approximate) will only be triggered if item isn't found in feature class. Meaning, as long as an item has been digitized it won't be possible to remove it from the projet legend.*
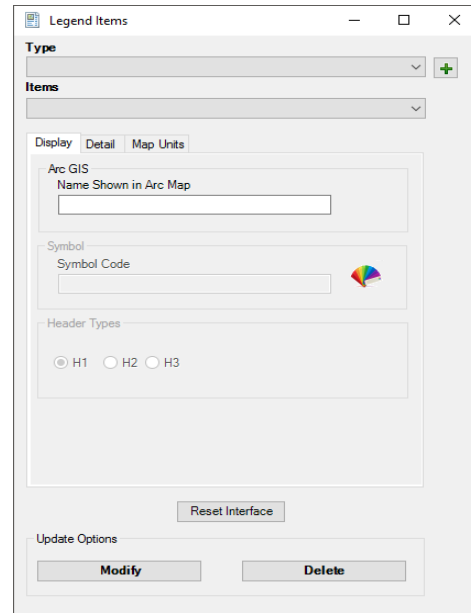
Figure 56: Legend Items dockable window, Display tab.

Display tab

- *Arc GIS (Name Shown in Arc Map)*: can be edited to reflect an alias for a selected item. The written name will be displayed and available in feature layer symbology, feature templates and in other places throughout the tools.
- *Symbol Code*: The text box displays the GSC code (e.g. 3.02.01.009) for the selected item. Clicking on the rainbow fan button, allows the selection of a new symbol.
- *Header Types*: This is used to modify the rank of the header if this type of item is selected.

Detail Tab

o *Geological Name*: A name associated with the selected item (e.g. Victoria Island formation, Cadillac Fault, Babiche Anticline, etc.)

⚠️ *WARNING: This is not the place to edit the complete item description as it will be displayed in the final map legend. Use the Item Description tool for that purpose (section 4.3.4)*

Figure 57: Legend Items, Detail tab.

Map Unit Specific Tab

o *Geological Rank*: The user is allowed to enter Rank information for the map units using terms available from the drop-down lists.

o *Cartographer*: The next two options are intended for the cartographer who must enter an appropriate coding line needed to correctly render both, the map unit label on the map legend (Coded Map Unit) and the map unit annotation as it must be displayed on screen (Coded Annotation) (e.g. ⊤Pg).

o *Label Update*: The user can change the value of a label here. Modification mode here are immediately followed by an automatic update of both the Feature template and the Feature Layer.

o *As an option, it's possible to set or unset a label as an overprint*.

⚠️ *WARNING: No label update will take place if a space or an empty text box is found.*

Figure 58: Legend Items, Map Units tab.

4.3.2 LEGEND ITEM ORDER

When building a legend for a whole project, it can be useful to see items placed in an order similar to that of the final published map. By clicking this tool a pop-window will show the item's order relative to other units. The user can then edit the order by moving items higher or lower in the legend hierarchy using the vertical arrows on the right side of the window. The colours on the left side of the items graphically identify its (surface, line, points and headers). Figure 59 shows a legend with map units in yellow, lines in blue, point symbols in green and headers in bold. The horizontal arrows below the list of items can be used to move items horizontally. Although these arrows don't impact the indentation within the legend table, they can be useful for viewing the content.
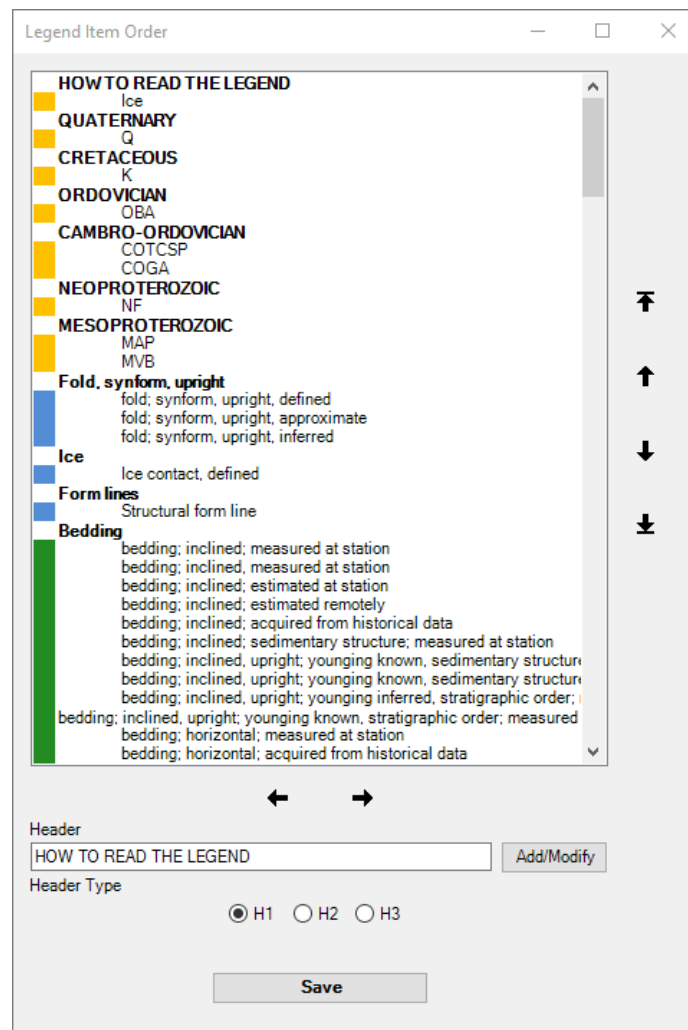

Figure 59 Legend Item Order interface.

Also, a header can be inserted into the list of items by typing a name and selecting the "Add to list" button. A header rank can be selected with the H1, H2, and H3 radio buttons. A header is modified by, selecting it in the header textbox, changing the value and then clicking "Add / Modify" to update the list.

4.3.3 INTERSECT LEGEND ITEMS WITH STUDY AREAS (NO INTERFACE)

The purpose of this tool is to spatially intersect all types of symbolized features (***GEO_LINES***, ***GEO_POINTS*** and ***LABELS***) with the spatial extent of each CGM map in a project. Specifically, the tool generates an index table containing a list of all types of features encountered in each CGM map, and providing the necessary information to automatically generate a legend for each individual map.

> ⚠️ *WARNING: a CGM map's bounding box (neatline) must exist in the* BGDB*. Use the tool "[Define Study Areas](#)" in the ArcCatalog™ Add-in to create or add the spatial extent of a CGM map.*

4.3.4 LEGEND ITEM DESCRIPTIONS

This tool provides the ability to create, edit and assign a legend description for all legend item types (lines, points, field stations, etc.) within CGM maps.

Although the user interface is simple to use, it requires an understanding of the processes triggered after each user action. Figure 60 illustrates three common examples when creating and editing legends. Across the three examples, the steps diverge when choosing how the description will be applied to the Project Maps list (steps 3-5 below).

In the first example (Figure 60 left), the user adds a new legend description for map unit Pmo and assigns the description to the legend of all CGM maps within the project. This is achieved by:

1) ***Type***: selecting 'Map Units (Labels)' from list;
2) ***Item***: selecting unit 'Pmo' from list;
3) ***Description***: selecting 'Add New Description' from list;
4) ***Project Maps***: checking box to 'All';
5) ***Description****: typing a legend description;
6) ***Add/Modify***: selecting button adds description to all project cgm maps.

In the second example (Figure 60 center), the user slightly modifies the description of the same unit, but the change is only applied to CGM254 and CGM255. This is achieved by:

1) ***Type***: selecting 'Map Units (Labels)' from list;
2) ***Item***: selecting unit 'Pmo' from list;
3) ***Description***: selecting 'Add New Description' from list;
4) ***Project Maps***: unchecking box from 'All';
5) ***Choice List***: selecting only CGM254 and CGM255 from list of project maps;
6) ***Description****: modifying the existing legend description to include 'locally with K-Feldspar meg-acrysts.';
7) ***Add/Modify***: clicking modifies the description only for maps 254 and 255.

The third example (Figure 60 right), illustrates assigning the modified 'Pmo' description from maps 254 and 255 to include map 258. This is achieved by:

1) ***Type***: selecting 'Map Units (Labels)' from list;
2) ***Item***: selecting unit 'Pmo' from list;
3) ***Description***: selecting the description "Orthopyroxene-biotite±magnetite monzogranite; locally

with K-feldspar megacrysts" from the list. The complete legend description is displayed in the *De-scription* text box;

4) *Project Maps*: By selecting this description, the choice list displays only the "checked" maps for which the description is currently assigned (i.e. maps 254, 255). Note that the Project Maps All button remains unselected;

5) *Choice List*: selecting cgm258 map (without unchecking the other two maps);

6) *Add/Modify*: selecting button adds the description to map 258, while maintaining it in for 254 and 255.
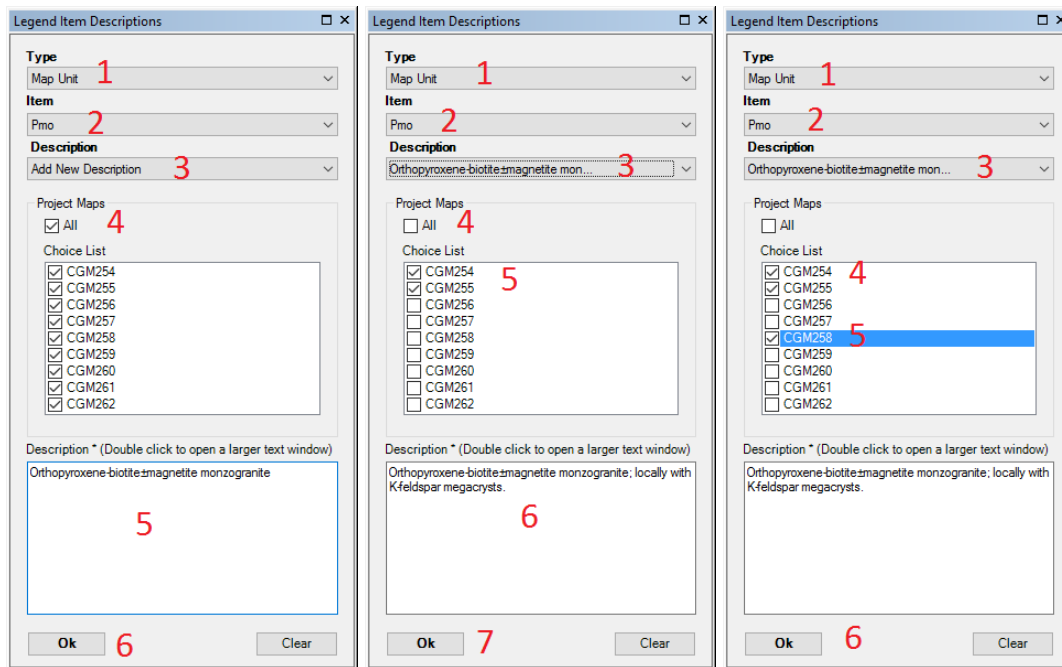

Figure 60: Legend Item Description interface showing three common examples and the steps needed to create and edit legends for CGM maps.

✓ *TOOLTIP: Double-clicking on the description box will open a larger text window, see Figure 30.*

✓ *TOOLTIP: The user should be aware that when an existing legend description is selected from the drop-down list under* <u>Description</u>*, the* <u>Project Map</u> *is updated with a list of the maps for which the selected description has been assigned. Unchecking any of these maps will result in missing description for the related map unit.*

4.3.5   CREATE TEMPORARY TABLE FOR LEGEND GENERATOR

The current data model presents the legend information across multiple *Tables* and *Relationship Classes* which reduces the risk of duplication. This structure is not easily compatible with the in-house Legend Generator tool. It has been recognized that the Legend Generator tool doesn't work well with joined *Tables,* creating a legend with a randomly organized order. To overcome this problem, this tool generates a temporary table called **P_LEGEND_GENERATOR_XYZ** that holds all the information needed for the preparation of a legend. The Legend Generator tool can use this table to generate a legend.

When the button is selected, a pop-up window prompts the user to refine its selection based on the list of maps already entered in the BGDB. Selecting one or multiple maps applies a spatial filter on legend items. Only items falling inside the selected maps outline boundary will be added to the output result.

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By checking *Include all project map units,* the user can create a Project Legend having all map units instead of only map units encountered in the selected CGM map. This option is useful for legends that need to show white boxes for map units that do not physically fall in the selected map area.
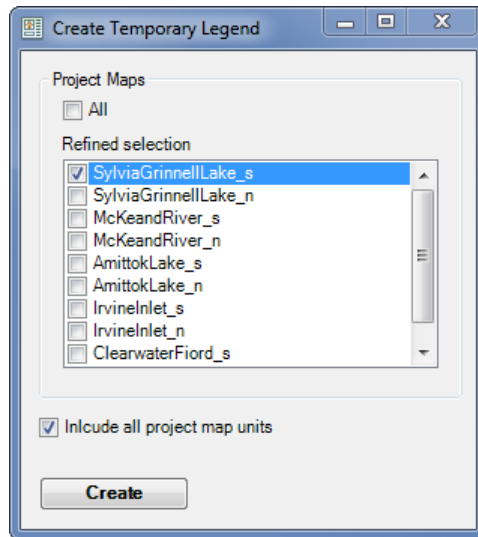
Figure 61: Available options to Create Temporary Legend table.

⚠ *WARNING: The temporary table output shouldn't be published.*

4.3.6   SURROUND INFORMATION

This tool offers the ability to store some of the more common and mandatory elements of a CGM map surround in the BGDB. Thus, the name of the map, the abstracts and the descriptive notes in both languages are managed here.
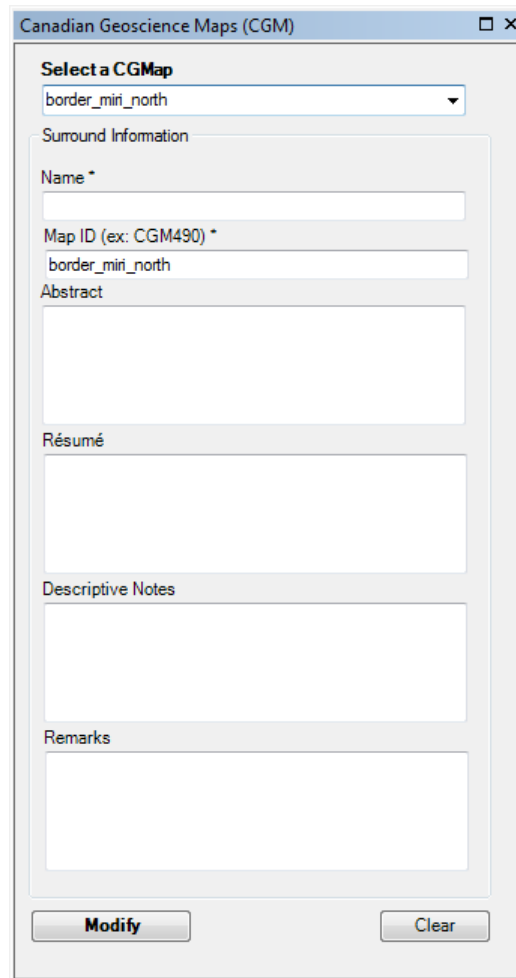

Figure 62: Canadian Geoscience Maps (CGM) dockable window.

✔ *TOOLTIP: Double-clicking on the Abstract, Resume or Descriptive Notes window will open a larger text box, see Figure 30.*

4.3.7   CREATE DATA BUNDLE (CARTOGRAPHIC PREPARATION)

This new tool was introduced to simplify the workflow for any maps that should go to publication as a Canadian Geoscience Map.

By using this tool, user will be able to create a data bundle (folders and esri geodatabases) for one or more selected map of any maps found inside the database. A spatial intersection will be conducted to clip and retrieve only the related elements of selected maps. The resulting databases can than be seen as external subset of a project database.

Setting a different projection is an option that becomes valuable when a map should be published in another UTM zone then its associated project database spatial reference. As another option, a user could link a database that will hold all feature subtypes as different feature classes. By doing so, it is easier for the cartographer to apply any cartographic representation if it is ever needed.
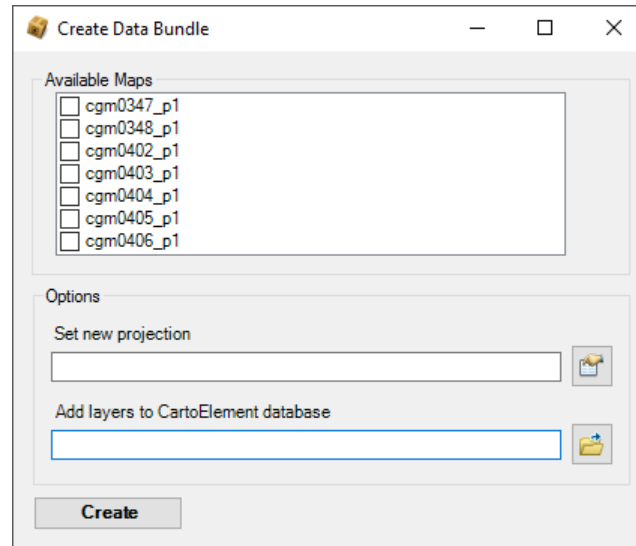

Figure 63: Create Data Bundle window example to select a map that will be extracted to another geodatabase for cartographic publication purposes.

5 METADATA TOOLS

5.1 SOURCE

This drop-down list of reference sources is intended to capture a *SourceID* for all feature objects created by the user. Reference sources displayed are stored in the table **P_SOURCE,** previously filled in when using the tool Source Dataset (see Section 3.3.1)
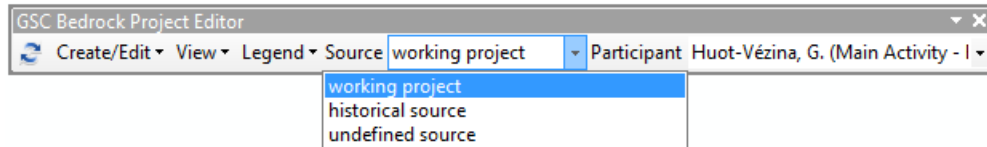
Figure 64: Drop-down list example for source metadata.

5.2 PARTICIPANT

This drop-down list of the project participants is intended to capture the author and/or the editor for all feature objects created/edited by a user. These metadata values are stored within the fields *CreatorID* and *EditorID* of the three main Feature Classes: **GEO_LINES**, **GEO_POINTS** and **LABELS**. The list of participants displayed here comes from previously entered data using tools described in Sections 3.2.2, 3.2.4 and 3.2.5.

Figure 65: Drop-down list example for author or editor metadata.

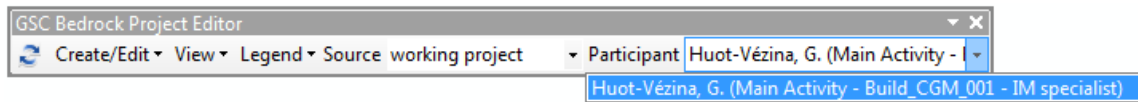# 6   MAP DOCUMENT TOOLS

6.1   REFRESH SYMBOLS

This button is necessary to overcome desynchronization between the Feature layers, the Feature templates and the object Feature displayed in ArcMap. The user can select the layer(s) to refresh by checking any layers within the INTERPRETATION group layers.
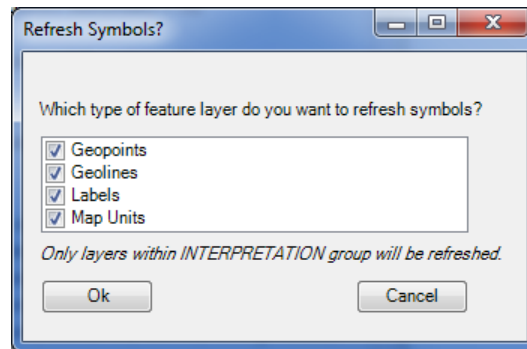
Figure 66: Refresh Symbols options.

There are at least four known situations where the user needs to perform a refresh in order to synchronize the working environment.

1. Each time a feature object is added from a newly-created template (the object itself and the feature layer are refreshed);
2. Following the use of the *Load Lines and Points* tool (see Section 3.3.4);
3. After creating a new MXD project file from an already filled BGDB;
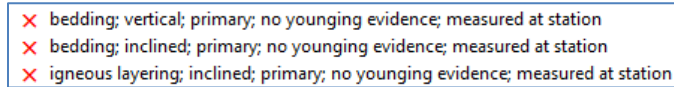4. Following any manual edits in the attributes tables of **GEO_POINTS**, **GEO_LINES** and **LABELS.**

Actions that are triggered by this tool are:

1) the update of the feature layer with all symbol values stored in the layer attribute table;
2) the update of the editing feature templates to reflect the symbols at a project level.

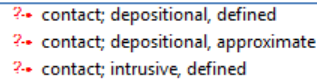Three types of errors could arise from a refresh operation:

1. In the attribute table, a given **GeopointID** or **GeolineID** has multiple symbol values assigned to it:
   - In this case, the tool displays aWARNING message to the user, but still draws the different symbols for the same **GeopointID** or **GeolineID** in the feature layer. For example, a **GeolineID** = 101001039999 (Contact, depositional, inferred) has a coded symbol value = 1.01.05. So, if the tool finds a different symbol value associated with that particular **GeolineID** , it will duplicate that type of line in the feature layer resulting in two different symbols for the same type of line (i.e **GeolineID**). The user must correct the data by editing it accordingly.
2. In the attribute table, a given **GeopointID** or **GeolineID** has a missing symbol value:
   - In this case, the tool assigned an invalid default symbol value resulting in
     1) a red X for a point (Figure 67);
     2) a plain red line with interrogation marks for a line (Figure 68).

- Invalid *GeopointID* or *GeolineID*. This scenario usually occurs when a manual edit generates erroneous attribute value(s) resulting in invalid *GeopointID* or *GeolineID*. In this case, the tool assigned an invalid default symbol value and a line is added to either the Geolines or the Geopoints feature layer with the following message "Missing Value from Scientific Language".

Figure 67: Resulting display for missing symbol values in the Geopoints feature layer.

Figure 68: Resulting display for missing symbol values in the Geolines feature layer.

TOOLTIP: Feature Layers are refreshed according to the values in the layer's attributes table. The user must be aware that a manual edit of the layer's attribute tables could lead to desynchronisation between the feature layers and the feature templates.

TOOLTIP: Feature Templates are refreshed according to the value within the Legend Generator table.

*WARNING: The Refresh Symbols button will only refresh the feature layers within the INTERPRETATION group layers. **The thematic layers created with the tool "Create thematic layer" won't be refreshed. To refresh those layers, the user must run the "Create thematic layer" tool again.***

7   STYLES

The default style used for geological features is named GSC_SymbolStandard and is available within the current publication package or from the source (Geological Survey of Canada, 2018). This file contains all symbols used for point (marker), line, polygon and text element used throughout any interpretation or mapping work. It is important to install all the fonts that are also delivered along side the style file.

For every new project, a folder named "Style" is created and is meant to contain default style or any other one needed for the project.

⚠️ *WARNING: Administrator rights are needed in order to install fonts on any computer runnign Windows.*

7.1   CUSTOMIZE

Customizing a style file can be an important part of a starting step for any interpretation work. Using bold and bright colored lines can help a user digitize elements on a scanned map or to help highlight some given features that needs special attention. Below is a step by step description on how to customize a style for working purposes. Note that using custom symbols could be seen as an error when a map needs publishing since it needs standard symbols.

Since the style files are stored within the project workspace folders (refer to Section 3.1.1), they can be easily edited. For example, a user may decide to symbolize all the faults with a single colour while digitizing interpretations. Following the digitizing process, the user can then change to a standard geological symbol using the "Item modification" tool to select the appropriate line or point symbol in the "Display" tab.

Here is the procedure to customize a project style file:

- In the ArcMap™ Table of Contents, right-click on a feature layer and select Properties.
  - Select the Symbology tab and double-click the symbol to modify its properties.
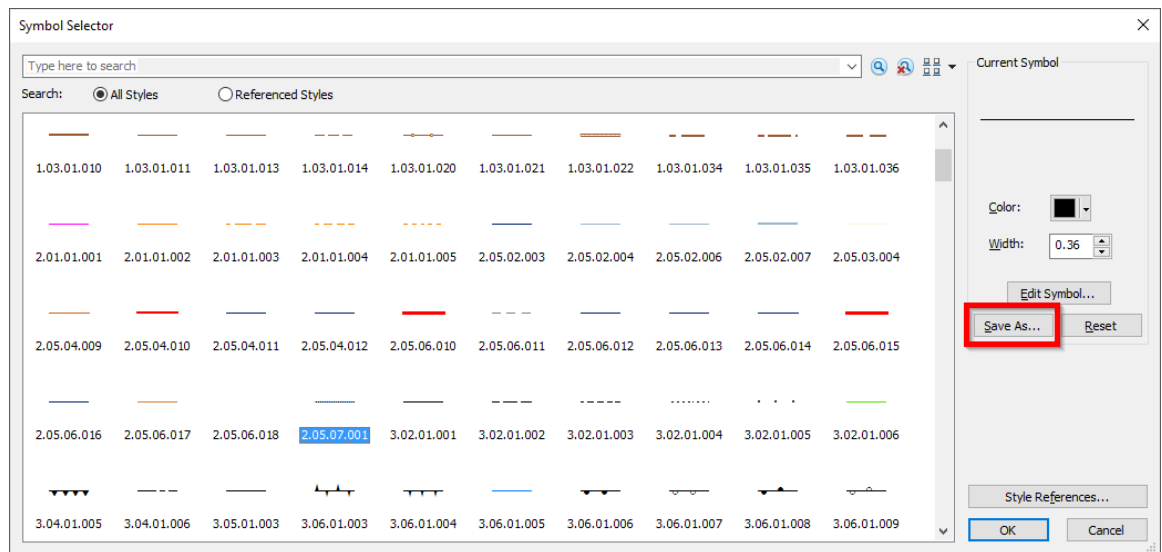
Figure 69: Symbol Selector window for customizing symbols.

- o   For the purpose of this example, the black colour has been changed to red.
- o   Click the "Save as" button, enter a name and choose which style file this new style will be saved in. Make sure the style is the one used in the project.
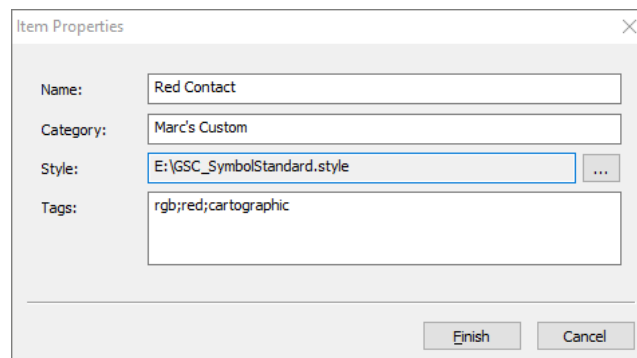

Figure 70: Item Properties for saving a custom symbol.

- o   Click the "Finish" button.
- o   Back in the symbol selector window, the new custom symbol is displayed at the end of the style. In some versions of ArcGIS™, the style may disappear from the window. It can easily be added back by clicking the "Style references…" button and browsing to the work-space style folder.
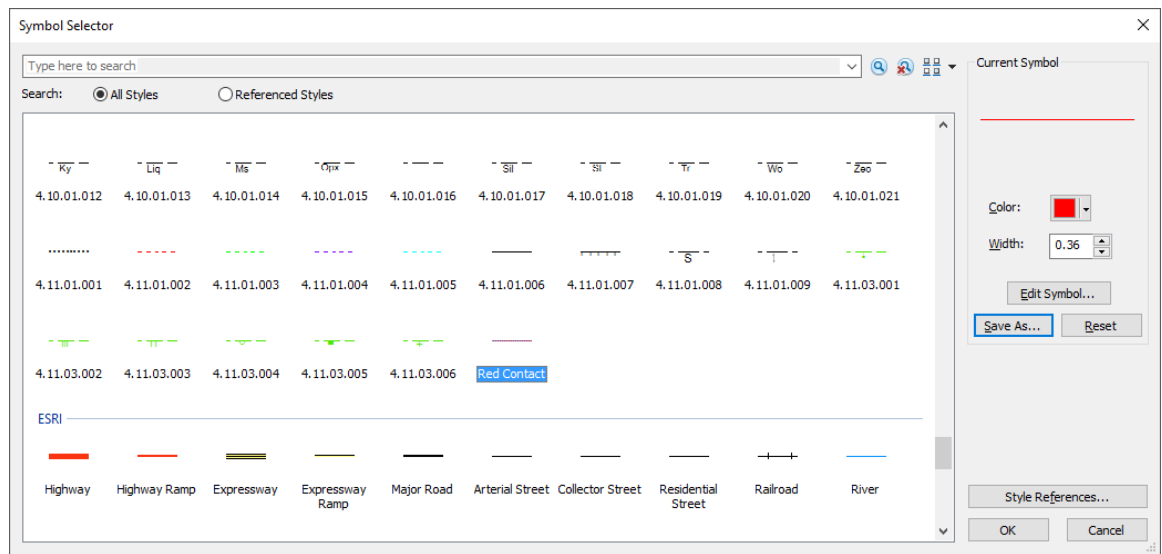
Figure 71: Symbol Selector window for displaying custom 'Red Faults' symbol.

INFO: *The maximum length of the Symbol Name is 15 characters.*

WARNING: *Using custom symbols for publishing a finished map is forbidden. Please use standard symbols provided by you scientific language committee.*

8   REFERENCES

Huot-Vézina, G., Boivin, R; Smirnoff, A., Paradis, S J., 2012. GeoScaler: Generalization tool (with a supple-mentary user guide in French); Commission géologique du Canada, Dossier public 6231, (éd. 2); 82 p. https://doi.org/10.4095/291993.

Geological Survey of Canada, 2018. Cartographic symbol standard for geologic map production; Geological Survey of Canada, Open File 8572, 101 p. https://doi.org/10.4095/xxxxxx

9 APPENDIX

9.1 FREQUENTLY ASKED QUESTIONS

Where to find the working environment stored parameters?

- C:\Users\{NRCan login name}\Documents\ArcGIS\Working_Environment.gdb

9.2 PROBLEMS AND ERRORS

9.2.1 TEMPLATES

There is no template being added in the dockable window "Create Features" during an editing session.

- Ensure the tools are being run with a Standard or Advanced ArcGIS licence.

9.2.2 SESSION

When starting an edit session in ArcMap™, an error message pops saying it can't access the project database.

- The current working MXD is new and hasn't yet been saved.
- Project data are not loaded inside the MXD.
- If ArcCatalog™ is open while attempting an edit session in ArcGIS™, a lock will prevent editing the data. Close ArcCatalog™ to enable editing.

Interface language change doesn't work properly when I change it in "Customize".

- To ensure a proper language change, close ArcMap™ and ArcCatalog™, then open them again. Doing this will force a new initialization of the language.
    - o Usually interfaces that are problematic are the dockable window type of control.

9.2.3   MAP UNITS

I can't see any map units when I launch the create map unit tool

- Make sure that label points fall inside the polygons
    - Use the Quality Control tool to find problematic map units.
    - Check topology of the Geolines, e.g. all vertices are snapped.

Problem arises if a refresh is launched with the layer and the symbols.

- Check for any join or relation that could have been made inside the feature layer
    - Map units should keep the join between the feature layer and table **_P_LEG-END._**

Can't create map units; resulting in error message.

- If you are using overprints in your map, check that the geoprocessing option "Overwrite existing data" is selected.