

# DIGITAL MAPPING TECHNIQUES 2024

The following was presented at DMT'24  
May 13 - 16, 2024

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## Template Geologic Map Databases, a scripted approach to applying attribute rules, domains, and workflow extensions to GeMS

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The Template Geologic Map Database Toolbox is an automated method to create enhanced Geologic Map Schema (GeMS) file geodatabases. Enhancements, including attribute rules, attribute domains, and other extensions, provide built-in quality control, simplify map compilation, help achieve level 3 GeMS compliance, and streamline data review. Moreover, scripting database creation eliminates manually performing time intensive and error prone tasks and easily supports multiple database options. The script is built as an Esri ArcGIS Pro Python Toolbox compatible with version 3.x. It provides a user interface with template options to configure the database to accommodate workflows of different projects, organizations, or individuals. The script uses the existing GeMS Toolbox (Thoms and others, 2024), to create the initial database. Downstream code then adds attribute rules, attribute domains, and other schema extensions based on user selections. The final output is a GeMS file geodatabase ready for either new data entry or to accept existing data from another database. Additional tools provide maintenance functions for the template database after creation.

Template creation involves three major steps. First, the user edits an included Microsoft Excel workbook that drives creation of attribute domains, population of GeMS nonspatial tables, and creation of other nonspatial tables required by attribute rules. The included starter workbooks provide comprehensive lists of point and line types, which can be customized or shortened as needed. Second, users select template options through the toolbox interface. Finally, the user runs the tool, which creates the GeMS database, adds applicable schema extensions, imports the information from the Excel workbook, and imports attribute rules from a folder within the toolbox directory based on selected template options.

Attribute rules are central to the template's quality control functions. Calculation and constraint attribute rules were first presented by Felger (2020) and later improved by Alexander and others (2023). GeMS databases are granular; individual features contain many interrelated fields. Keeping these fields synced and up to date is challenging and time consuming. Data reviews are equally complex. Attribute rules eliminate much of the manual work around creating, updating, and reviewing data in GeMS. Calculation and constraint rules are Arcade-based, user-defined scripts available in Esri's ArcGIS Pro software. Arcade is an expression language created and maintained by Esri, which loosely follows JavaScript conventions, and is useable throughout the ArcGIS product line. Attribute rules can automatically calculate dependent attributes, prevent incorrect data entries, and ensure users populate required fields both during feature creation and editing. This speeds up data creation, enhances data quality, and simplifies data review.

With attribute rules, a user picks a point or line symbol, digitizes the feature, and then calculation rules lookup the symbol in a separate nonspatial table to retrieve dependent attribute values such as Type, IsConcealed, ExistenceConfidence, and IdentityConfidence, among others. Constraint rules ensure DataSourceID and MethodID, if applicable, are completed. Map-unit polygon feature classes use a similar workflow with the DescriptionOfMapUnits (DMU) table serving as the lookup table. Label is referenced from the DMU, and a question mark is appended if the unit has a questionable IdentityConfidence.

Attribute domains provide quality control by constraining field-level data input to a list of choices. This standardizes the field's data formatting and restricts inputs to valid entries. Domains are already included for some fields in a GeMS database created via the GeMS Toolbox. One example is the ExIDConfidence

domain, which restricts values in IdentityConfidence and ExistenceConfidence fields to *certain* or *questionable*. Template databases expand domains to more fields including Symbol, MapUnit in applicable feature classes, and DataSourceID. Symbol domains are designed to yield useful legend labels. MapUnit domains include name and age information for easy reference. DataSourceID uses a human readable abbreviated citation format. Keeping the Symbol and MapUnit fields domain controlled ensures calculation attribute rules will succeed when querying their associated lookup table. The DataSourceID domain restricts users to valid sources. Templates also allow for customization of domain formats to suit other workflows.

Template toolbox options support a variety of rules and schema extensions for different workflows. A MapUnitLabelPoints (MULP) feature class with all applicable rules and domains can be included in template databases to allow building of polygons from ContactsAndFaults and MULP. Templates can either enforce ExistenceConfidence and IdentityConfidence as equal values or allow for different values. LocationConfidenceMeters, on a symbol-by-symbol basis, can either be auto-populated by attribute rules or are required to be completed manually. Templates can also automatically maintain GeMS\_ID fields. A Method table, MethodID field, MethodID domain, and attribute rule requiring MethodID can be added. MapUnitLines can use either map-unit codes or FGDC codes in their Symbol field. Lastly, templates can include additional map-unit fields to track composite units in a surficial geologic map database. These additional fields include SubordinateMapUnit, UnderlyingMapUnit, BedrockMapUnit, and CompositeMapUnit. Attribute rules construct CompositeMapUnit from the pieces, populate BedrockMapUnit where applicable, enforce rules around acceptable composite units, construct composite labels, and can parse composite units from a legacy PTYPE field into appropriate GeMS and map-unit fields. Without attribute rules, these additional map-unit fields would be difficult to maintain.

The toolbox includes a second workflow to aid in converting existing databases to take advantage of enhancements using the template approach. Incoming data must meet attribute rule requirements and follow applicable domain formatting. This requires review and cleanup of the original database. The toolbox documentation walks users through this process. The script for creating the destination conversion database includes options to turn off attribute rules and editor tracking to aid in appending data. A separate utility tool can then reactivate rules and tracking after appending data and prior to using the newly converted database.

The toolbox is hosted on the USGS GitLab instance as a version-controlled repository; currently only available to USGS staff. It includes documentation to walk users through template creation and is hosted as a static site on GitLab Pages. It also provides “Getting Started” tutorials to familiarize users with attribute rules and the toolbox. Documentation is written in Markdown and converted to HTML with MkDocs and the Material theme. With the documentation and toolbox, users can easily generate a template database suited to their needs that greatly reduces workloads associated with creating and maintaining data in a GeMS database.

#### References Cited:

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