Miscellaneous Report 170 v. 2

AK GEMS DATA DICTIONARY: A DESCRIPTION OF THE ALASKA GEOLOGIC MAPPING SCHEMA

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AK GEMS DATA DICTIONARY: A DESCRIPTION OF THE ALASKA GEOLOGIC MAPPING SCHEMA

Michael D. Hendricks[1], Amy E. Macpherson[1], Jennifer E. Athey[1], W. Chris Wyatt[1], Simone Montayne[1], Wes Buchanan[1], Pedro G. Rivera[1], and Ally M. Steinleitner[1]

INTRODUCTION

To meet local geologic mapping requirements, the Alaska Division of Geological & Geophysical Surveys (DGGS) designed the Alaska Geologic Mapping Schema (AK GeMS), which is an extension to the Geologic Mapping Schema (GeMS; U.S. Geological Survey [USGS] National Cooperative Geologic Mapping Program, 2020). This document and accompanying Microsoft Excel workbook (hereafter referred to as the data dictionary) describes the organization and logic of AK GeMS. It is intended to serve as a multi-use, comprehensive reference document for an AK GeMS compliant geodatabase. A data dictionary catalogs and communicates the structure and content of data and provides meaningful descriptions for individually named data objects (USGS, 2020).

Uses of this data dictionary may include:

- As a reference guide for geologic mappers populating relevant features and fields in an AK GeMS production geodatabase.
- As a reference guide for data leads while finalizing an AK GeMS production geodatabase.
- As a reference guide for AK GeMS GIS administrators while conducting quality control on an AK GeMS production geodatabase.
- As a form of metadata for users of any published AK GeMS geodatabases.

Supporting files are available to download from doi.org/10.14509/31172.

- AK GeMS data dictionary file excel file.
- XML document of the geodatabase contents, ak_gems_template_ver_2.xml, which can be used to create an AK GeMS geodatabase.
- Schema reports in json, excel, html, and pdf formats, generated with ESRI ArcGIS Pro.

Details on symbolizing data utilizing the AK GeMS extension can be found in a related report, AK GeMS symbology: A description of the AK GeMS style file, v. 2 (Macpherson and others, 2024, doi.org/10.14509/31101).

CHANGES IN VERSION 2.0

There are a number of changes from the original database schema (Hendricks and others, 2021). Changes to the data dictionary are highlighted with purple text for additions and purple strikeout text for deletions. Major categories of changes include.

- Addition of fields within existing feature classes.
- A number of changes to field definitions, such as string length, string to integer, etc.

[1]Alaska Division of Geological & Geophysical Surveys, 3354 College Rd., Fairbanks, Alaska 99709-3707.

- Additions to attribute domains, including:
    - The addition of expanded Landslides category and type values within the geologic point, line, and polygon attribute domains.
    - The addition of expanded Volcanic category and type values within the geologic point, line, and polygon attribute domains.
    - Geochron attribute domains.
- New samples point feature class.
- New standalone attribute tables—symbol_info and map_unit_age_abbrev_lookup.
- Fixing typos and blunders.
- Changes to Data Dictionary Documentation.
- 146 new glossary records were added and defined to raise the number of glossary terms to 563.
- Note: Tables with static data, such as glossary, and geomaterials retained the same GUID id value between ver 1.1 and ver 2.0.

AK GEMS DESIGN CONSIDERATIONS

The following elements are key design considerations of the AK GeMS extension:

- Focus on modeling geologic features and information relationships (as opposed to graphic element display) to better support quality division-wide map production, database queries, and web delivery.
- Capability for exporting to the GeMS without significant loss of essential information.
- Capability for supporting both single map production geodatabases and the DGGS multi-map PostgreSQL enterprise geodatabase.
- Support for multiple geologic layers (e.g., bedrock, surficial, others).
- Formalized pick-lists of attribute domains that are fully defined in a glossary table.
- Integration with DGGS's publication workflow and digital data management infrastructure, including the Alaska DGGS Geologic and Earth Resource Information Library of Alaska (GERILA) enterprise database (DGGS Staff and Papp, 2005).

To meet these design considerations AK GeMS supports various geodatabase implementations as part of the overall Alaska DGGS Geologic Mapping System (fig. 1). Each of these implementations has several unique characteristics:

- **Single Map AK GeMS Production Geodatabases.** This implementation of AK GeMS uses the full AK GeMS specifications, including string-based attribute domains, as described in the data dictionary.
- **Single Map AK GeMS Publication Geodatabases.** A public distribution version of an AK GeMS geodatabase. It excludes topologies, as well as feature classes and tables that are empty or only required for production. Production focused fields, such as the editor tracking fields, are typically removed as well.
- **Single Map GeMS National Archive Geodatabases.** The GeMS standard has several naming conventions that differ from AK GeMS, particularly the use of Pascal case instead of underscore word delimiters for table and field names. See the accompanying data dictionary spreadsheet for field name correlation between AK GeMS and GeMS. Also see appendix B for an in-depth description of the differences.

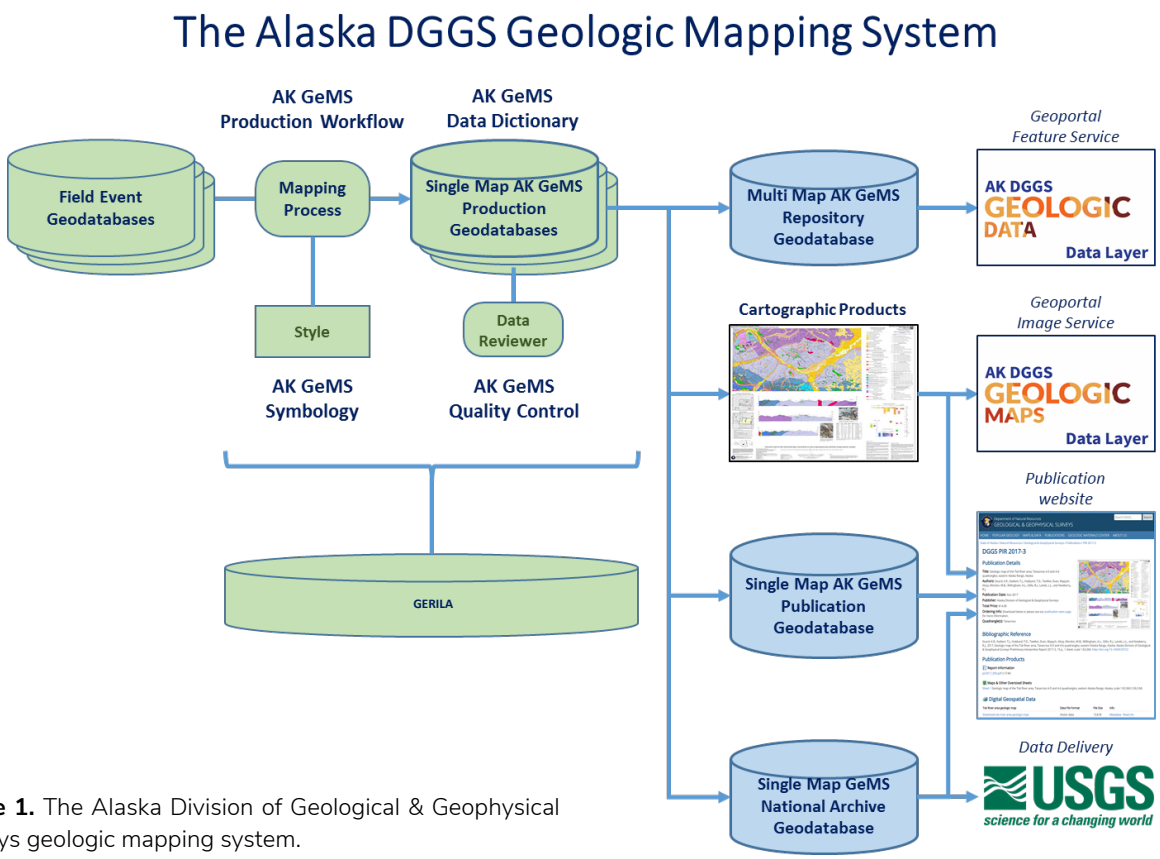

Figure 1. The Alaska Division of Geological & Geophysical Surveys geologic mapping system.

- **A Multi-Map AK GeMS Repository Geodatabase.** A modified AK GeMS geodatabase hosted on PostgreSQL enterprise architecture. This geodatabase modifies the standard AK GeMS schema in several ways, such as the use of integer-based attribute domains and true Globally Unique Identifiers (GUID) type fields. Details of these modifications are not addressed directly in this publication.

AK GEMS GEODATABASE DESIGN

AK GeMS organizes the feature classes and stand-alone tables into groups that include map units and boundaries, structure information, other geologic information, thematic points, and cartographic features (figs. 2 and 3). These feature classes and stand-alone tables include the required GeMS classes as well as several custom feature classes and stand-alone tables to meet DGGS requirements. Details of each of these feature classes and stand-alone tables are provided in the accompanying data dictionary spreadsheet.

Naming Conventions

To enable multi-user editing on enterprise geodatabase architecture, specifically PostgreSQL, AK GeMS modified the GeMS table and field names to use the snake case naming convention, which converts compound words to lower case words combined with an underscore. For example, “MapUnitPolys” becomes “map_unit_polys.”

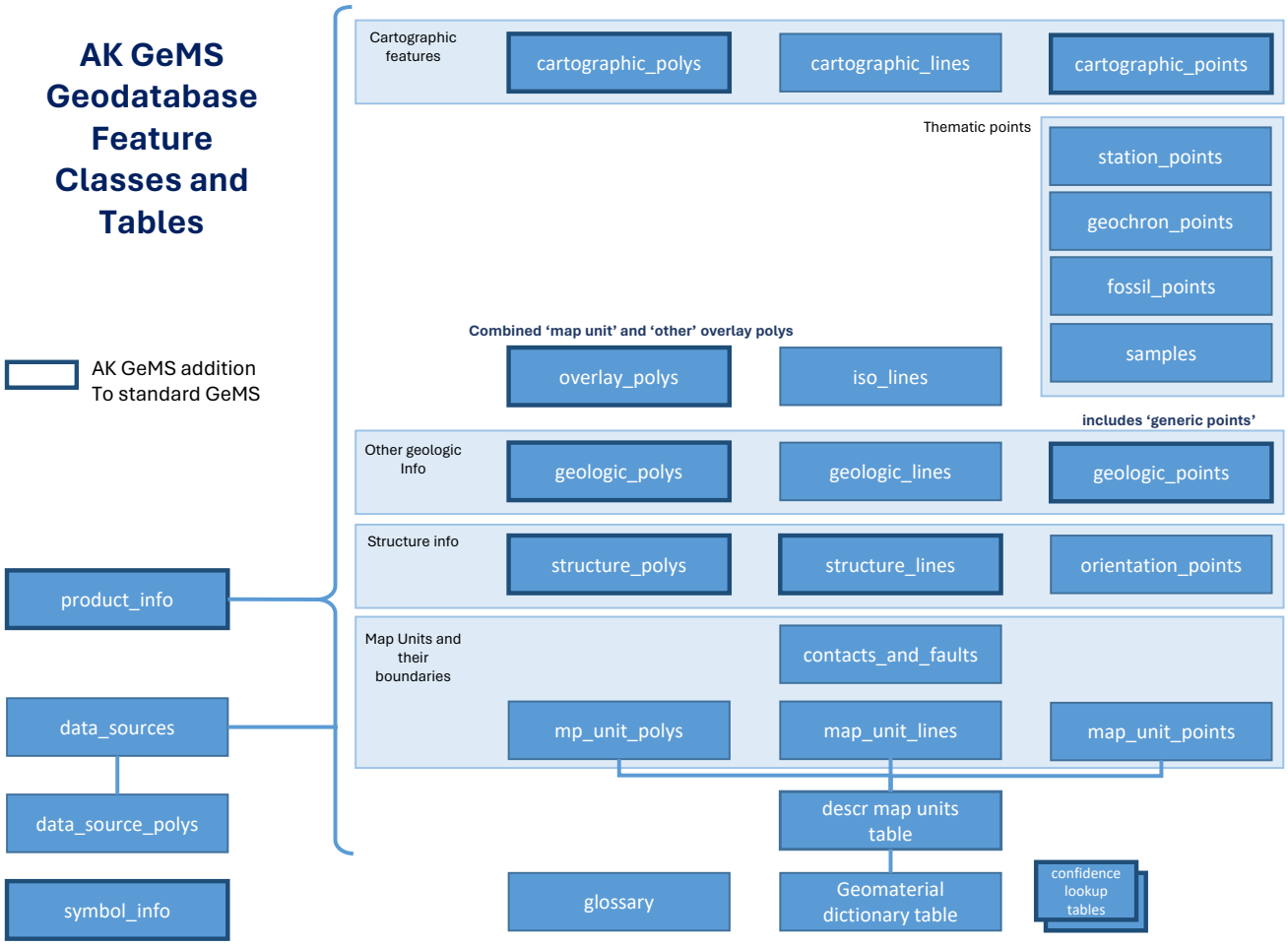

Figure 2. Organization of the AK GeMS geodatabase features classes and tables.

Layering of Geologic Features

Geologic features are inherently three-dimensional. Classic print-based geologic maps, however, are two-dimensional representations of this complex, three-dimensional reality. The AK GeMS database is not designed as a true 3D geologic map database but does provide limited capability to store information about the simple "layering" of geologic features.

The GeMS specification, as published by the USGS, assumes a single planar topology of map features, particularly map unit polygons and contact and faults. The USGS validation tools build and check data against a single planar topology, and as a result, layered map unit polygons (which allow for overlap) are not allowed and get flagged as errors. To extend beyond this single planar topology within the database, the AK GeMS database design includes a "layer" field to define in which planar topology layer each feature resides.

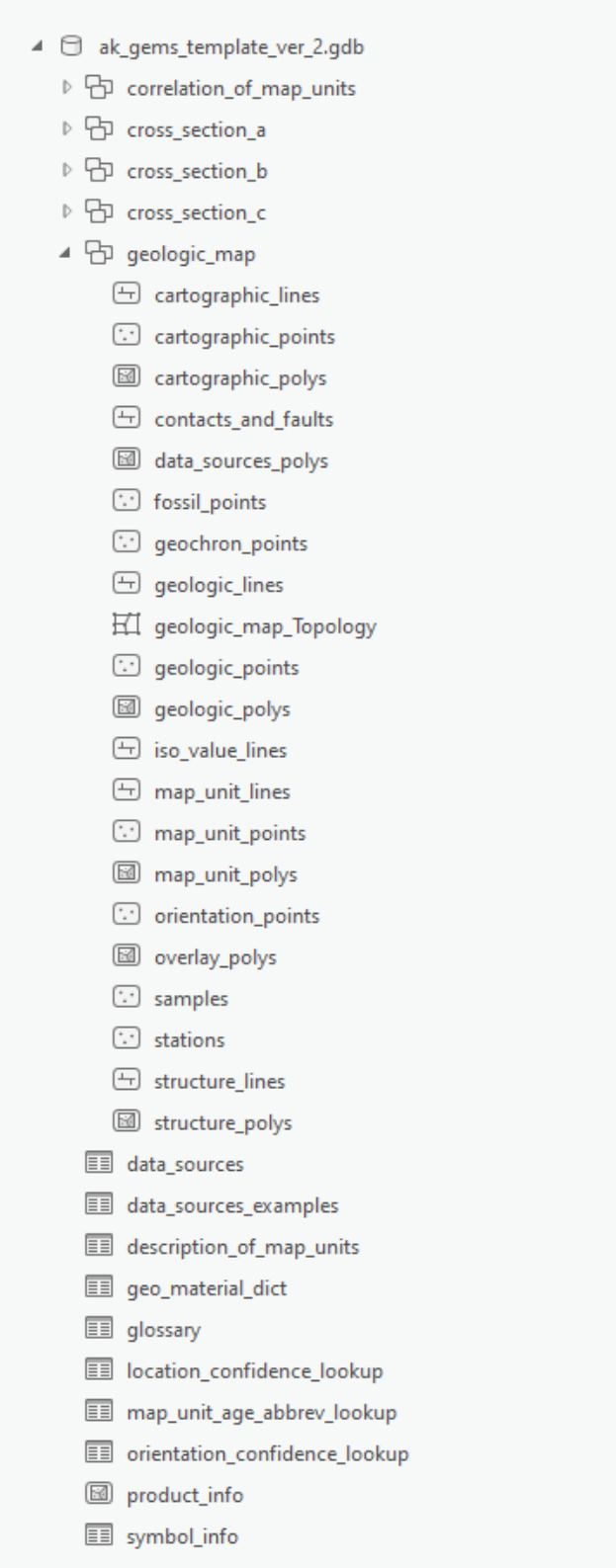

Figure 3. Feature classes and tables in the AK GeMS geodatabase.

The AK GeMS layer field is a signed integer value. The bedrock layer closest to the surface is assigned a layer value of -1. If bedrock layers below this primary mapped bedrock layer are included in the database, they receive decreasing negative values for each subsequent lower layer. The primary mapped layer above the bedrock, typically surficial deposits or volcanics, is assigned a value of 1, with additional layers above being assigned increasing positive values for each subsequent higher layer.

Contacts and faults receive the layer value of the map_unit_poly features they are splitting or defining. Faults (or contacts) that are represented in multiple layers are assigned a value of 0 to indicate they span multiple layers. Contacts that define the map boundary (type = boundary, map) are assigned a value of 0. Map_unit_polys are not split by contacts from a different layer. For example, a bedrock unit (layer = -1) is not split by the layer 1 contact splitting two surficial units (layer = 1).

Feature Representation Hierarchy

The idea that a feature's symbol code is part of the feature's representation hierarchy is a central concept for AK GeMS. Features within the AK GeMS Database are modeled within a hierarchy of increasing level of detail through the use of category, type, and symbol fields within each feature class (stand-alone attribute tables only have category and type). The category and type fields have well-defined and nested attribute domains.

The most generalized level is the feature class (e.g., contacts_and_faults). The next level of detail is the category field, which stores a subdivision of logically associated geologic map features (e.g., a feature in the contacts_and_faults feature class might be a fault). These category values are typically further divided into one or more types as defined in the type field (e.g., fault, low angle). Note that the category and type fields for all feature classes have well-described attribute domains within AK GeMS. The next level of detail within a feature's representation hierarchy is the symbol field itself (e.g., a

feature of type fault, low angle, has a symbol value of 02.03.01 if its identity and existence are certain and its location is accurate). The final level of detail in our hierarchy is the symbol description for each symbol; a description such as "Low-angle fault (unknown or unspecified sense of slip)—identity and existence certain, location accurate" is taken, when possible, directly from the FGDC symbol documentation.

Database Relationships

AK GeMS supports certain relationships among feature classes and tables. Appendix A provides an Entity_Relationship (ER) diagram of these relationships. These relationships are color-coded and categorized into the conceptual groups:

- Product Identification Relationships
- Data Source Relationships
- Map Unit Relationships
- Points Feature Class to Stations Relationships
- Associated Feature Relationships
- Relationships to the Alaska DGGS GERILA database

As part of the AK GeMS design, we implement GUIDs. GUIDs are 128-bit values that uniquely identify records in the database, for example, {1051D9B2-9B8D-4997-9E3C-3EEE0836B781}. Since GUID field types can be difficult for geologists and map makers to work with, temporary human-readable ID values are used by DGGS during the production phase. As a result, in the Single Map Implementation of AK GeMS, ID fields throughout the geodatabase are set as String type with a length of 50. These values are overwritten by GUID values before publication. In a multi-map implementation, a true GUID field type is used.

Product Identification Relationships

To ensure that AK GeMS data can be easily integrated into a multi-map implementation, every feature class and table includes a field named product_id [string length 50 in a single map product geodatabase], which is a foreign key to the product_info table's product_id field. These relationship fields are color-coded green (without connecting lines) in the ER diagram provided in appendix A.

Data Source Relationships

GeMS requires feature-level source metadata. Every feature class and table include a data_sources field, which is a foreign key to the source field in the data_sources table. This relationship is inherently a many-to-many relationship. As a result, AK GeMS allows multiple, semicolon-delimited entries in the data_sources field of Single Map AK GeMS Production and Publication Geodatabases. The data_sources field is type String, length 150. This field's expected value is an in-text citation format; for example, "Foster, 1992" or "Foster, 1992; Day and others, 2007" are valid data_sources field values. We use this format instead of an integer or GUID value during production and publication of single map geodatabases to make citing feature-level metadata more intuitive for the geologist making the map and examining the data. Note that in the Multi-Map AK GeMS Repository Geodatabase implementation, a GUID-based many-to-many relationship class is built with this relationship. These relationship fields are color-coded salmon (without connecting lines) in the ER diagram provided in appendix A.

There are several deviations and additions to the basic data source relationship described above:

- The description of map units table has a description_source_id field in lieu of the data_sources field.
- The geochron_points feature class has a second source identification field, analysis_source_id, which is a foreign key to the sources field in the data_sources table. In practice, this field supports only single values.
- The fossil_points table has three additional fields: analysis_source_id, fossil_forms_source_id, fossil_age_source_id. In practice, these fields support only single values.

The data_sources_polys feature class can be used to create an inset map indicating the geographic extent of data sources used to support geologic interpretations. There is a one-to-one relationship between the data_sources_polys feature class and the data_sources table via the data_sources_id field.

Map Unit Relationships

Within the Single Map AK GeMS Production and Publication Geodatabases, there is a many-to-one relationship between records in the map_unit feature classes (map_unit_polys, map_unit_lines, and map_unit_points) and the description_of_map_units table via the map_unit field. Also, there is a many-to-one relationship between the description_of_map_units table and the geo_material_dict table via the geo_material field; see light blue lines in figure 4 and appendix A.

These relationships require the use of unique identifiers in the Multi-Map AK GeMS Repository Geodatabase implementation. To ensure this, GUID-based relationships are established; see purple lines in figure 4 and appendix A.

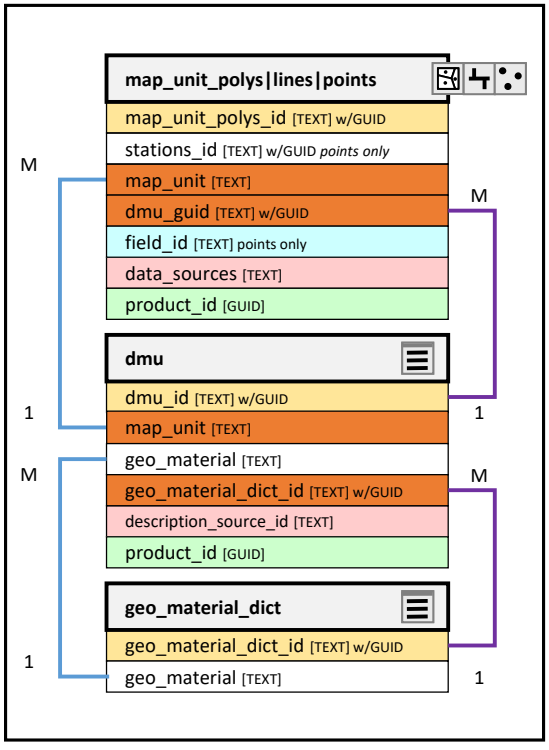

Figure 4. Relationships within the Single Map AK GeMS Production and Publication Geodatabase.

Points Feature Class to Stations Relationships

Features within the stations point feature class typically represent the location where a geologist collected a measurement or observation. These stations are often referenced by various thematic point features, such as orientation_points, geochron_points, fossil_points, and map_unit_points. These point feature classes have an optional relationship with the stations feature class. In other words, these feature classes do not require a relationship to a station, but in practice, these points typically do have this relationship. These relationships are shown with a dark blue connecting line in the ER diagram provided in appendix A.

Associated Feature Relationships

The orientation_points and cartographic_points feature classes include an assoc_field_id field that can be used to relate a feature, via a GUID, to another feature in one of several other feature classes, including map_unit_points, map_unit_lines, map_unit_polys, contacts_and_faults, structures_lines, etc. The primary use of this rela-

tionship is to associate decoration types with other mapped features. For example, a dip symbol decoration can be associated with a fold feature stored in the structure_lines feature class. These relationship fields are color-coded steel gray (without connecting lines) in the ER diagram provided in appendix A.

Relationships to the Alaska DGGS GERILA Database

The GERILA database is the primary clearinghouse for distributing Alaska's geologic data in digital formats. This Linux-based PostgreSQL database drives our publications and metadata distribution process, and stores all stations, samples, and map extents. Several fields in AK GeMS relate map data to values in the GERILA database. These relationship fields are color-coded cyan (without connecting lines) in the ER diagram provided in appendix A.

CHANGES IN AK GEMS FROM GEMS

Changes in AK GeMS from the more-generic GeMS are as follows:

- Changed table and field names from PascalCase to snake_case to better support PostrgeSQL database requirements. For example, MapUnitPolys becomes map_unit map_unit_polys.
- Added the requirement to have a bounding polygon feature class product_info to store the boundary of the map as well as numerous product information attribute fields.
- Added numerous fields to store supplementary feature descriptive information. Examples include:
    - product_id: Foreign key to product_info feature class. Unique identifier of the database product. Required for ingestion into the AK GeMS Multi-map Database. This is a GUID value.
    - category: A subdivision of logically associated geologic map features within a feature class; a category is typically further divided into one or more types as defined in the 'type' field. Categories are typically taken from the group heading in the FGDC Symbology Standard.
    - layer: An integer value indicating a feature's planar topologic layer. This field allows us to have multi-layered geologic data.
    - modifier: Identifies if this feature is modified in some way, such as hornfelsed, migmatite, etc.
    - distribution_policy: Flag indicating to whom and how this feature can be made available.
    - data_sources_method: The method the data source used in this database. Examples include "New feature based primarily on field mapping", "Feature unmodified from source material."
    - location_confidence_method: Identifies the method by which location confidence is assessed, e.g., "specified" defined as "the feature's location confidence is primarily identified with a numeric value provided by the geologist in the location_confidence_meters field."
    - group_id: Group features, such as faults, folds, map unit, etc., that get split because of attribute changes.
- The use of GUID values for nearly all ID fields.
- MapUnit information field split into map_unit_observed and map_unit_associated fields.
- map_unit_assoc: The map unit in which this feature is located on map. This is typically the topmost map unit in a layered database.

- map_unit_observed: The map unit observed in the field that is associated with this feature, e.g., an observation of a small igneous body within a larger map unit unmappable at the current map's scale.
- data_sources_id field uses human readable in-line citation format, for example, "Athey, 1999."
- assoc_feature_id: The GUID of a feature from a different AK GeMS feature class with which a point feature, such as an orientation point, is associated.
- draw_policy: Controls if the feature is drawn on the map product.

DATA DICTIONARY EXCEL FILE ORGANIZATION

The data dictionary Excel file is organized into the following tabs:

- **Tables List tab:** A description of the tables (feature classes and stand-alone tables) included in AK GeMS. The following columns are included in this tab:
    - Feature Dataset: The feature dataset where the table resides.
    - Table: The name of the table in AK GeMS.
    - Table Description: The description of the table.
    - Example Features or Records: Example features that may be included in the table.
    - Notes: General notes associated with the table.
    - GeMS Table Name: The name of the table when mapped to a GeMS database.
- **Domains List tab:** A description of the coded and range domains in AK GeMS.
    - Domain Name: The name of the domain in AK GeMS.
    - Description: The description of the domain.
    - Field Type: Field type using Esri terminology.
    - Domain Type: The type of domain, coded or range.
    - Split Policy: The split policy set in the template database.
    - Merge Policy: The merge policy set in the template database.
    - Where Used: Which tables have this domain for a field.
    - Notes: General notes associated with the domain.
- **Tabs for each thematic table:** The following columns are included in these tabs:
    - Field Name: The name of a field.
    - Description: The description of the field.
    - Data Type: Field type using Esri terminology.
    - Default Value: Default value set in the template geodatabase.
    - Null Value Allowed: NULL values are not allowed in the published geodatabase.
    - Multiple Values Allowed: Can multiple values occupy this field value? If so, individual values should be delimitated with a semicolon.
    - Example Values: Example values that might be found in this field.
    - Domain: The domain name with a link to the domain values.
    - Lineage: From where this field was derived. 'GeMS' indicates the field maps directly to a field in the GeMS Schema. 'AK GeMS' provides a field unique to AK GeMS. 'Esri' indicates that the Esri software adds this field.

- Notes: General notes associated with the table.
- When: When this field is populated.
- Who: Who populates this field.
- How: How this field is populated.
- Field Name GeMS: The related field name in the GeMS standard.

- **Domains Coded Values tab:** The single tab with the unique values included in each coded domain.
  - Code: The integer value of the domain. This value is used only in the multi-map database.
  - Description: The description of the domain value. This description is used as the code value for the single map AK GeMS and GeMS databases.
  - Glossary Definition: Definition of the domain value that is in the glossary table.
  - Notes: General notes associated with the value.
- **Domains Range Values tab:** The description of the range of values in each range domain.
  - Field Type: Field type associated with this domain. Typically, field type of Float.
  - Minimum: Minimum value of the range.
  - Maximum: Maximum value of the range.
- **Suggested Values tab:** The suggested values for select fields that do not have attribute domains.
  - Value: The suggested value.
  - Glossary Definition: Definition of the suggested value that is used in the glossary table.
  - Notes: General notes associated with the value.
- **geo_material_dom tab:** The unique values of the geo_material_dom domain. This table is directly replicated from GeMS. There is no integer code associated with this domain.
  - Code: The string value of the domain.
  - Description: The description of the domain value.
  - Notes: General notes associated with the value.
- **location_conf_lookup_TABLE tab:** A scale-based lookup table used to convert location confidence values to numeric values. Only applicable to the single map production AK GeMS database.
- **orientation_conf_lookup_TABLE tab:** A lookup table used to convert orientation confidence values to numeric values. Only applicable to the single map production AK GeMS database.
- **map_unit_age_abbrev_lookup_TABLE tab:** A lookup table that contains the relationship between FGDC special character geo age font labels with approved DGGS Map Unit abbreviations.
- **Topology tab:** A description of topology rules suggested for use with a single map production AK GeMS database. Only applicable to the single map production AK GeMS database.
  - Feature Class 1: The feature class involved in the topologic rule.
  - Rule: The topological rule name.
  - Feature Class 2: If applicable, the second feature class involved in the topologic rule.
  - Notes: General notes associated with the rule.
  - Lineage: From where this field was derived. “GeMS” indicates the rule is identified in the GeMS documentation. ‘AK GeMS’ indicates a rule added to AK GeMS.

- **Glossary Definitions tab:** Listing of all glossary definitions. These definitions are stored in the glossary table. The glossary definitions are either directly defined in the AK GeMS data dictionary or referenced from the AGI Glossary of Geology (American Geosciences Institute, 2020).
    - Term: Term that is defined.
    - Glossary Definition: The definition of the term.
    - Data Source: Source of the definition.

SINGLE MAP PRODUCTION PHASES, ROLES, AND METHODS (WHO, WHEN, HOW)

The AK GeMS data dictionary provides general guidance on database production for a single map production database. Additional guidance is provided by internal DGGS documentation. General guidance on phases, roles, and methods is provided with values in three columns, identified as When, Who, and How within the data dictionary.

Phases (When)

- Prep: The beginning phase of the mapping project. The database is generated and project-specific settings, such as coordinate systems, are set in this phase. Typically, only the product_info table has values assigned in this phase.
- Fieldwork: Fieldwork associated with the mapping project.
- Interpretation: The interpretative phase of the mapping project.
- Pub Prep: The Pub Data Lead calculates database-centric fields from data populated in the interpretation phase.
- Pub: In this phase the database is prepared for publication.
- On the fly: Continuously occurring phase with on-the-fly calculations by Esri software.
- Static: Data is static.

Roles (Who)

- Geologist: The geologist(s) editing the geodatabase while producing the geologic map.
- Pub Data Lead: The map publication data lead for the geodatabase.
- GeMS Admin: The GIS team GeMS administrator for the geodatabase.
- Esri: The ArcMap or ArcPro software on-the-fly calculations.

Method (How)

- Manual: Manually entered value.
- Calculated: Calculated programmatically by software or script.
- Picked: Picked from an attribute domain.
- Imported: Values imported from an outside data source.
- GPS: Values generated from GPS-based collections in the field.

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APPENDIX A: AK GEMS KEY RELATIONSHIPS