

AK GEMS SYMBOLOGY: A DESCRIPTION OF THE AK GEMS STYLE FILE

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Supplemental Files

The following supplemental files are available to download at: doi.org/10.14509/31101

AK_GeMS_symbology_documentation_ver_2.xls

x AK_GeMS_symbology_ver_2.stylx

Cover photo. The Okmok geologic map illustrates the usage of AK GeMS symbology. doi.org/10.14509/31015

AK GEMS SYMBOLOGY: A DESCRIPTION OF THE AK GEMS STYLE FILE

Amy E. Macpherson¹, Michael D. Hendricks¹, and Jennifer E. Athey¹

INTRODUCTION

Symbols for geologic maps are built, stored, and delivered with a database schema that is driven primarily through the use of symbol codes representing specifications found in the Federal Geographic Data Committee (FGDC) Digital Cartographic Standard for Geologic Map Symbolization publication (U.S. Geological Survey, 2006), hereafter called the FGDC standard. To represent additional visualization requirements, the Alaska Division of Geological & Geophysical Surveys (DGGs) has created custom symbols with associated symbol codes. These code-based symbol specifications are stored digitally and available to Esri GIS software in a style file, as specified in the U.S. Geological Survey (USGS) Geologic Map Schema (GeMS), a standardized database schema (database design) for the publication of geologic maps (USGS National Cooperative Geologic Mapping Program, 2020).

This document describes the organization and content of the current style file used by DGGs for the Alaska GeMS map production standard. The Alaska GeMS map production standard (hereafter referred to as AK GeMS) is a standard schema based on the USGS GeMS schema that has been modified and expanded to more fully represent DGGs map and data requirements, including functionality for a multi-map database version of the schema. Database tables and field names in AK GeMS are similar to those in USGS GeMS, but do not match exactly. For example, AK GeMS uses underscores in field and table names (such as `contacts_and_faults`) to facilitate storage in a PostgreSQL database, while USGS GeMS uses pascal case field and table names (such as `ContactsAndFaults`). All accompanying files are available to download from the DGGs website: doi.org/10.14509/31101.

A BRIEF HISTORY

The DGGs GeMS Symbolology style file was originally derived from a style file built by the Geological Survey of Canada (GSC), who painstakingly created a majority (but not all) of the symbols in the FGDC standard. From 2014 until 2019, DGGs built upon this foundation and added a limited number of custom symbols in a set of style files named `DGGs_Map_Symbolization.style`, `DGGs_Map_Symbolization_ver2.style`, and the short-lived `DGGs_Map_Symbolization_ver3.style`.

In 2020, DGGs initiated a significant update to the geologic map style file that includes a change in how custom symbol codes are codified and used, and included the following elements: colors, `map_unit_point` marker symbols, and `map_unit_lines` line symbols based on the standard FGDC color codes. In addition, the name of the style file was updated to align with AK GeMS and published as version 1 of AK GeMS symbolology (Ekberg and others, 2021).

Since the publication of version 1 in 2022, numerous symbols have been added as well as changes made to existing symbols. In 2023, with the impending deprecation of Esri's ArcMap software, the decision was made to migrate the style to ArcGIS Pro (.stylx file format). Some older, retired features were removed during this process and some updated and more complete symbol sets were added.

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SYMBOL CODES

The FGDC standard identifies symbol codes for colors, patterns, and geologic features (USGS, 2006). Below is a short description of each and how the AK GeMS style employs these codes.

Color Codes

The FGDC standard specifies a four-digit color Cyan-Magenta-Yellow-Black (CMYK) code to represent colors. These CMYK colors were designed to closely match the USGS original offset-printed, process-ink color chart, “Printing Colors and Screens in Use by the U.S. Geological Survey for Geologic and Hydrologic Maps” [yellow/magenta/cyan version], which has long been used at the USGS for choosing colors on geologic maps. The FGDC color chart contains the same colors as the original offset-printed USGS color chart; however, the old color codes indicating the YMC (yellow/magenta/cyan) values have been updated to show CMYK (cyan/magenta/yellow, with black = 0) values, to conform to industry standards.

For each code, each digit represents the percent of cyan (C), magenta (M), yellow (Y), or black (K). Color codes use the following abbreviations: A=8 percent; 1=13 percent; 2=20 percent; 3=30 percent; 4=40 percent; 5=50 percent; 6=60 percent; 7=70 percent; X=100 percent. For example, the code 40X0 represents a yellow-green color that is comprised of 40 percent cyan, 0 percent magenta, 100 percent yellow, and 0 percent black.

While DGGS employs the four-digit CMYK-based code, the FGDC color chart also provides a three-digit generic lookup-table number that can be used to reference a color. A lookup table and scripts are available from DGGS upon request to assist in converting between various color codes and models.

Pattern Codes

FGDC standard patterns are identified by a pattern number, which includes a 3-digit number followed by a letter identifying the color of the pattern. For example, code 101-K represents pattern 101 (a pattern comprised of randomly dispersed small open ovals and dots) shown in black (K). Pattern 101 can also be shown in cyan (code 101-C), magenta (code 101-M), or dropout (code 101-DO). Standard patterns are in Section 38 of the FGDC standard and on its accompanying pattern chart. While the FGDC pattern chart also provides a three-digit lookup-table symbol number that can be used to reference a pattern, DGGS employs the number and letter-based coding.

Geologic Features Codes

The FGDC standard employs a dot-based hierarchical numbering logic for its symbol codes. For example, symbol code 1.1.1. is “Contact—Identity and existence certain, location accurate.” The first digit indicates that it is within the Contact, Key Beds, and Dikes category, the second digit indicates it is within the Contacts sub-category, and the third digit is the specific symbol. Some symbols, however, do not have a sub-category; for example, code 6.1 is “Horizontal bedding.”

For convenience, DGGS pads single-digit FGDC symbol code values with a leading zero to assist in sorting. For example, FGDC code 1.1.1 becomes 01.01.01. Feature code groups that have over 100 items are padded with an extra decimal place (i.e., 09.010.01). The symbol code associated with each feature in a GeMS geodatabase is stored in the feature classes’ symbol field (type string, length 10).

Symbol Codes for Map Unit Polygons, Map Unit Lines, and Map Unit Points

Map unit polygons, lines, and points in AK GeMS use the four-digit color CMYK-based color code described earlier in the color codes section.

Symbol Dictionary Table in AK GeMS

A symbol lookup table, named `symbol_dict` in AK GeMS, provides access to the symbol code's description, derived when available from the FGDC standard. For example, symbol code 02.03.01 has a description of "Low-angle fault (unknown or unspecified sense of slip)—Identity and existence certain, location accurate."

STYLE FILE CONTENTS

Some of the contents and types of symbols have changed from the previous version (1.0) to this version, primarily deprecated symbol types such as Representations are no longer present, and Marker Symbols are now called Point symbols (fig. 1). A list of the Style Classes in the `stylx` file, and the changes or additions (if any) DGGs has made, is provided below:

Scale Bars

The Scale Bar Class contains one scale bar style representative of the specifications found in the FGDC standard section 35 for scale bars and scale text.

Colors

The Colors Class contains all colors from the color chart of the FGDC standard. Color symbols allow for colors to be viewed and accessed in the ArcGIS Pro color selector palette.

Polygon Symbols

The Polygon Symbols Class contains many symbols that can be categorized into the groups listed below. The symbol code identifying each fill symbol differs according to these groups.

Map Unit Fill Symbol Based on USGS Suggested Colors

Colors and patterns can be used to fill map units and other polygons in polygon feature classes in AK GeMS (`map_unit_polys`, `overlay_polys`, etc.). The colors from the USGS Suggested Colors for Geologic Maps² plate (USGS, 2006) are included as fill symbols in the style file. The fill symbols are coded by the four-digit CMYK color code (e.g., 40X0). This is particularly useful when using the option to symbolize features according to a style file based on values in a field (which you can now do in ArcGIS Pro). In AK GeMS, the four-digit color code (e.g., 40X0) is used as the symbol code in the symbol field for map unit polygons.

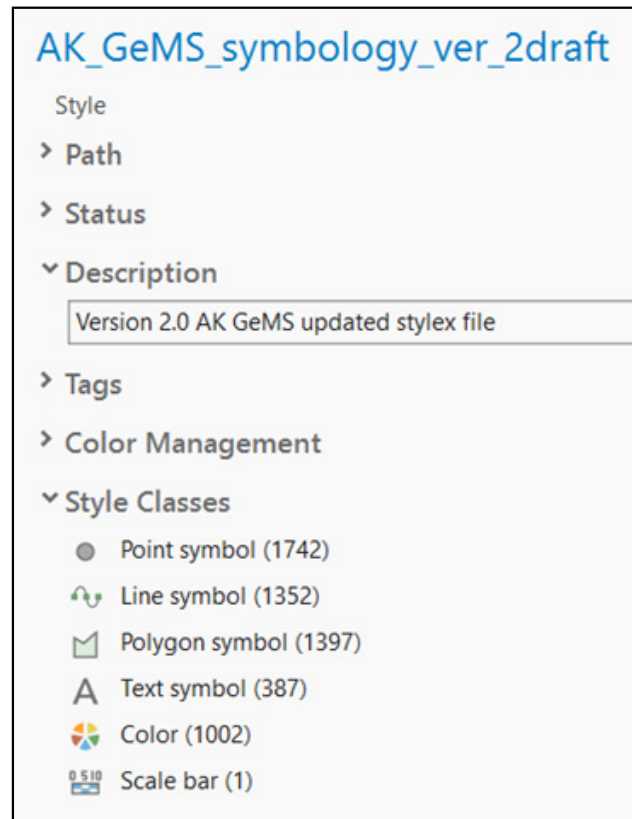


Figure 1. The contents of the `AK_GeMS_symbology_ver_2.stylx` file when viewed in the Catalog Pane inside ArcGIS Pro. Numbers next to the Style Classes indicate the number of symbols in each class.

²The color and pattern suggestions in this publication are examples of what could be used on a geologic map and do not necessarily form a strict or complete standard. Many factors should be considered when selecting colors for a geologic map. Additional guidance and recommendations are provided in section 5, "Guidelines for Map Color and Pattern Selection," of the introductory text in the FGDC standard (U.S. Geological Survey, 2005).

FGDC Standard Fill and Pattern Symbols

Other FGDC standard fill symbols are identified by their dot-based FGDC symbol code—similar to the convention used for line and points symbols. These FGDC standard fill symbols are either based on a single color, such as symbol code 01.02.42 (area of outcrop), or built on a standard pattern, such as 20.07 (hazardous waste site pattern 226-R with line weight of 0.25 mm outline). There are currently 17 FGDC standard fill symbols from various FGDC standard sections.

While the previous version of the style file contained only a limited number of patterns, all of the standard FGDC patterns are represented in the new stylx file excepting the dropout (-DO) versions (not used in AK GeMS).

Line Symbols

The Lines Symbols Class contains many line symbols that are used in different line feature classes in AK GeMS (contacts_and_faults, structure_lines, map_unit_lines, etc.). Line symbols can be categorized into the groups listed below. The symbol code identifying each line symbol differs according to these groups.

AK GeMS Map Unit Line Symbols Based on USGS Suggested Colors

These custom line symbols are used to symbolize features in the map_unit_lines feature class in AK GeMS. The symbol code for each map unit's line symbol is the FGDC color code that corresponds to the color of a map unit (e.g., 40X0). DGGS is creating these map unit line symbols as they are needed, so there is not a line for every FGDC suggested color.

FGDC Standard Line Symbols

All standard FGDC line symbols are represented in this class. These symbols are most often used in the contacts_and_faults and structure_lines feature classes.

AK GeMS Custom Line Symbols

DGGS has created custom line symbols to be used when there is no FGDC symbol available for a geologic feature, or if an FGDC symbol needs to be repurposed. These custom symbols are explained further in the next section.

Point Symbols

The Point Symbols Class contains many point symbols that are used in the different point feature classes in AK GeMS (e.g., orientation_points, geochron_points, map_unit_points, etc.). Point symbols can be categorized into the groups listed below. The symbol code identifying each point symbol differs according to these groups.

AK GeMS Map Unit Point Symbols

These custom point symbols are used to symbolize features in the map_unit_points feature class in AK GeMS. The symbol code for each map unit point symbol is the FGDC color code that corresponds to the color of a map unit (e.g., 40X0). There is a map unit point symbol for every FGDC suggested color.

FGDC Standard Marker Symbols

Almost all standard FGDC marker symbols are in this folder. This includes symbols for point features (e.g., symbol 06.02 represents a bedding symbol in the orientation_points feature class) and marker decorations that can be placed at a point or along a line (e.g., symbol 02.11.01 represents a ball and bar decoration to show normal offset of a fault).

Text Symbols

DGGS does not use text symbols directly for symbolization based on a field in an attribute table. Symbol text specifications can be used as a starting point and then modified to create labels or annotation feature classes.

Custom Symbols and AK GeMS Symbolology Documentation Excel Spreadsheet

The `AK_GeMS_symbolology_documentation_ver_2` spreadsheet is an update to version 1, originally developed to explain the custom symbols created by DGGS for use in AK GeMS. Updates to this spreadsheet are denoted by red text. Symbols are grouped into seven appendices, each with a separate worksheet tab, depending on their origin and use in AK GeMS. Due to Microsoft Excel character-length limitations for worksheet names, some abbreviations are used in tab/appendices naming.

Each tab has a Symbol Type column that explains a symbol's general use and identifies whether the symbol is an FGDC Standard or DGGS custom symbol (table 1).

Table 1. Definitions of the symbol type definitions in the `AK_GeMS_symbolology_documentation_ver_2` spreadsheet.

Symbol Type	Definition
FGDC Primary	The primary and expected FGDC symbol used to draw a feature type stored in an AK GeMS database.
FGDC Secondary	A substitute FGDC symbol used to draw a feature type stored in an AK GeMS database. These symbols should not be used without coordination with the AK GeMS admin staff. See the <code>assoc_symbol_code</code> field for this secondary symbol's primary symbol.
FGDC Decoration	A FGDC symbol used to enhance, or decorate a symbol. For example, a plunge direction.
FGDC Decoration Secondary	A substitute FGDC symbol used to enhance or decorate a symbol. For example, a plunge direction. These symbols should not be used without coordination with the AK GeMS admin staff. See the <code>assoc_symbol_code</code> field for this secondary symbol's primary symbol.
FGDC Alternate	An alternate FGDC symbol used to draw a feature with special characteristics stored in an AK GeMS database. A typical example of an alternate symbols is an orientation point with multiple observations at one locality. See the <code>assoc_symbol_code</code> field for this symbol's primary symbol.
FGDC Not Used by AK GeMS	The FGDC symbol is not currently used by DGGS
FGDC Not Available in Style	The FGDC symbol is not available in the current style file.
AK GeMS Custom Primary	Custom symbol made by DGGS staff for features that do not have a standard FGDC symbol or in cases where a FGDC symbol needs to be repurposed.
AK GeMS Custom Secondary	Custom substitute symbol made by DGGS staff for features that do not have a standard FGDC symbol or in cases where a FGDC symbol needs to be repurposed.

Appendices A–G (viewable as separate tabs in the supplemental excel file) describe and explain variations of the custom symbols in the FGDC and AK GeMS standards. In each tab, information includes the AK GeMS category and type; and a feature description that provides details about the symbolized feature that might not be in the feature attribute table. The appendices are as follows:

FGDC Standard Symbols—This tab explains all the FGDC standard symbols in the style file as they are found in the FGDC standard. Symbols are listed by their FGDC symbol code, with padded zeros (e.g., 01.01.01).

Compound FGDC Symbols—This tab explains compound symbols that are created from two or more standard FGDC symbols. Typically, these are lines that need to have a repeating decoration along them, or a second symbol level of line color. Symbols are listed by the first FGDC symbol code / second symbol code (e.g., 02.04.03/02.11.04).

Custom Symbols w FGDC Sections—This tab explains custom symbols that fit into the established FGDC standard sections. The symbol codes all start with the FGDC section and subsection into which the feature corresponds, followed by ‘ak’ and a unique number (e.g., 01.03.ak.01).

Custom Symbols NO FGDC Sections—This tab explains custom symbols that DO NOT fit into the established FGDC standard sections. The symbol codes all start with ‘ak’, followed by a group number (starting at 101 and assigned based on AK GeMS category), and followed by a unique number (e.g., ak.101.01).

Symbols with alternate colors—This tab explains FGDC and AK GeMS custom symbols that need to be shown in alternate colors. In the FGDC standard, the notes on usage for many symbols indicate that a symbol “may be shown in other colors”. It can be hard to show the same symbol in different colors on the same map using dynamic symbolization. The default color, as shown in the FGDC standard, is the default color for the symbol in the style file. When an alternate color is needed, a custom symbol is created that uses the standard symbol code and the CMYK color code of the alternate color. For example, FGDC standard symbol 18.56 is a volcanic vent that has a default red color. When needed to be shown in black, the feature is symbolized with code 18.56.XXX0. To conform with the FGDC color convention of K=0, the code XXX0 is used to represent black.

map_unit_point Symbols—This tab explains the convention for symbolizing map unit points. The symbol code for map unit points is the FGDC color code that corresponds to each map unit’s color.

map_unit_line Symbols—This tab explains the convention for symbolizing map unit lines. The symbol code for map unit lines is the FGDC color code that corresponds to each map units color.

LAYER FILES

DGGS also provides a series of layer files (.lyrx) with each GeMS deliverable. These layer files enable the user to quickly symbolize the feature classes within the GeMS database with the appropriate GeMS symbology, labeling settings and in the case of orientation points, correct symbol rotation.

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