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Creating FGDC-Compliant Cartographic Representations

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Introduction

The Alaska Division of Geological & Geophysical Surveys (DGGS) has begun incorporating cartographic representations into recent digital geologic maps. This is part of our effort to transition to using the Federal Geographic Data Committee (FGDC) digital cartographic standard for geologic map symbolization. This national standard provides line symbols, point symbols, colors and patterns which are used to make geologic maps and products that are more consistent in both their appearance and their underlying database content. The FGDC standard symbols, colors, and patterns can be represented in ArcMap as either traditional symbology or cartographic representations. Unlike traditional symbology, cartographic representations allow for more effective display of data by offering more control over symbol properties, drawing effects, and symbol storage.

FGDC standard symbols and representations can also be incorporated into the U.S. Geological Survey's (USGS) National Cooperative Geologic Mapping Program (NCGMP) proposed standard for geologic data (NCGMP09).

The Geological Survey of Canada (GSC) has created a style file that contains many of the FGDC standard line, marker (point), and text symbols. The GSC FGDC style file can be downloaded from the USGS's NCGMP09 website:
http://ngmdb.usgs.gov/Info/standards/NCGMP09/
It also has a few fill symbols to symbolize key beds, dikes, mass-wasting areas, and miscellaneous map elements. However, the GSC style file contains no representation rules or fill symbols to represent the USGS suggested colors or FGDC patterns for geologic maps.

The DGGS GIS team has created a style file that, in addition to the GSC symbols, includes fill symbols to represent the USGS suggested colors for geologic maps, and cartographic representations to symbolize the FGDC patterns. The DGGS style file also contains a few cartographic representations that are translated directly from the GSC styles. Pattern fill representations are made from scratch using Adobe Illustrator swatches and ArcMap.

Transforming FGDC Symbols Into Representations

THE PROCEDURE

Translating the symbols in the GSC style file is a good way to quickly make cartographic representations, particularly for point and line symbols. When translating symbols, extra attention must be paid to the size of the symbol. During conversion, the size of the symbol changes slightly. This is due to the conversion between points and millimeters.

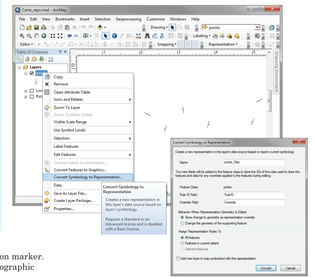
TRANSFORM TRADITIONAL SYMBOLOGY

A) Symbolize the data using the appropriate symbols from the GSC style file and convert the symbology to representations (Figure A).

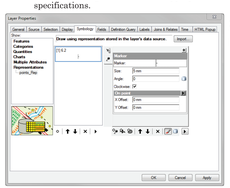
B) Manually adjust the size of the representation marker (Figure B). Refer to the FGDC cartographic standards for correct size information.

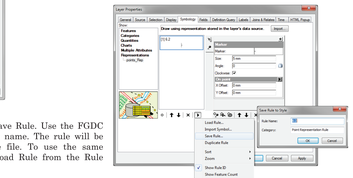
C) Save the rule (Figure C). Once saved as a representation rule, the symbol will not need to be translated again for future use.

A Right-click on the symbolized layer. Select Convert Symbology to Representation. Click Convert to translate the symbol to a representation marker.



B The data points are now symbolized with a representation marker. Manually change the size to the appropriate FGDC cartographic specifications.





C Under Rule Options, select Save Rule. Use the FGDC reference number as the rule name. The rule will be saved to your personal style file. To use the same representation later, select Load Rule from the Rule Options menu.

Creating Pattern Fill Representations From Scratch

THE PROCEDURE

Patterns are useful to enhance the differences between geologic units with similar unit colors and can provide additional information about lithology. Until recently, the choices for patterns in ArcMap were limited by the use of traditional symbology. The options were limited to patterns that could be constructed using only line, marker, and picture symbols. The Esri Geology 24K style file released with the ArcMap software contains only 35 picture fill symbols. When applied to a map, the Geology 24K patterns are pixelated. In contrast, patterns created using marker symbols within a representation rule are crisp and consistent at any scale.

1 — SELECT A PATTERN TO CREATE

Patterns are most often used for surficial, igneous, and volcanic units. The first patterns to be created were chosen from the Selection of Colors and Patterns for Geologic Maps of the U.S. Geological Survey Techniques and Methods 11-B1 manual. In the 11-B1 manual, pattern 416 is generally used to show gravel, sand and gravel, conglomerate, and glacial moraine deposits (Figure 1a). Pattern 416 can also be found in the FGDC Pattern Chart (Figure 1b). This chart identifies that pattern 416 is considered a miscellaneous or metamorphic pattern that is in the 400 series and is acceptable in 4 different color configurations – black (K), cyan (C), magenta (M), and dropout (DO).

2 — DOWNLOAD ADOBE ILLUSTRATOR FGDC SWATCH AND CREATE A "TEMPLATE TILE"

Most FGDC patterns were designed using Adobe Illustrator 8.0.1 to closely replicate patterns in the informal Technical Cartographic Standards volume (U.S. Geological Survey, ca. 1975). An Adobe Illustrator swatch library containing pattern swatches is available for download at:
http://pubs.usgs.gov/tm/2006/11A02/
The first step to creating an FGDC cartographic representation pattern is to create a "template tile." This will be used as a template when creating the representation markers, which will be added in ArcMap later.

a) Create a new artboard in Adobe Illustrator and open the FGDC swatch library (Figure 2a).

b) Create a rectangle that covers the entire artboard, assign the fill color to be the 416-M pattern, and change the stroke width to be zero (Figure 2b).

c) Export the artboard as a PNG file (Figure 2c).

3 — TRANSFORM THE TEMPLATE TILE INTO A CARTOGRAPHIC REPRESENTATION RULE

When creating cartographic representations from scratch, it is useful to create a new geodatabase (called Carto_Reps.gdb in this example) that contains three simple feature classes – one of each geometry type. When making patterns, use a polygon feature class (called Polygons in this example) which contains only one polygon. This helps improve draw time for complex patterns.

a) Symbolize the feature class with the newly created PNG file as a single picture fill symbol (Figure 3a).

b) Convert the polygon symbology to a representation rule. (Figure 3b).

4 — CREATE AND CUSTOMIZE THE REPRESENTATION RULE

a) Open the Marker Editor for the representation rule that was just created (Figure 4a).

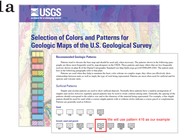
b) Use the drawing tools to create a dot and an open circle and place them over the template tile (Figure 4b).

c) Duplicate and modify the markers (Figure 4c).

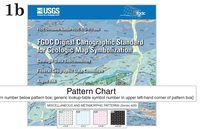
Patterns as cartographic representations

Pattern from Esri Geology 24K style file

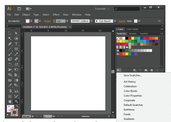
1a



1b

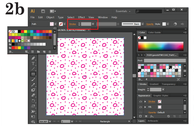


2a



The size of the artboard needs to be 22 mm wide and 22 mm tall. These are the exact dimensions of the pattern tiles on the FGDC Pattern Chart. If the FGDC library is not shown on the dropdown list, select Other Library and navigate to it.

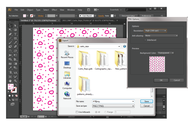
2b



Use the rectangle tool to draw a rectangle that covers the entire artboard. Select pattern 416-M from the swatch library on the sidebar. Use the fill symbol dropdown box to choose pattern 416-M. The template tile is now complete. On the path toolbar at the top of the window, change the stroke width to 0 pt.

Note:
Use one of the colored swatches (cyan, magenta, or red). This will make it easier to see the black marker symbols that will be placed on top of the template tile.

2c

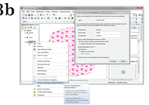


When exporting the artboard as a PNG file, choose High (300 ppi) resolution, no antialiasing, and transparent background color. These options will speed up draw time when using the template tile in the ArcMap Representation Marker Editor.

3a

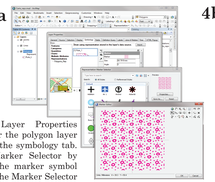
Using the Layer Properties dialog box, symbolize the layer as a single symbol. Use the Symbol Selector to edit the symbol. Choose Picture Fill Symbol from the Type dropdown list. Navigate to, and open the PNG file that was saved in the earlier step.

3b



Right-click on the symbolized layer. Select Convert Symbology to Representation. Click Convert to translate the symbol to a representation marker.

4a



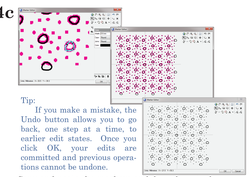
Open the Layer Properties dialog box for the polygon layer and activate the symbology tab. Open the Marker Selector by clicking on the marker symbol for Rule 1. The Marker Selector stores predifined marker symbols. Open the Marker Editor by clicking the Properties button.

4b

Note:
Getting the correct size of a marker is a bit tricky. A good starting point is to make the circle the same size as on the template. However, if left at this size, the markers will end up being too thick in the final pattern. A good size is usually just under half the size of the markers on the template tile.

Additional markers can be added on top of the template tile by using the Marker Editor. Use the Create Circle drawing tool to create a dot. Use the Create Line tool to make the large open circle. Adjust the line width and dot size to be roughly just under half the thickness of the template tile.

4c



Tip:
If you make a mistake, the Undo button allows you to go back, one step at a time, to earlier edit states. Once you click OK, your edits are committed and previous operations cannot be undone.

Copy and paste the markers and drag them to the corresponding magenta template markers. The open circles will need to be rotated at various angles to match up. Place markers over the magenta markers that are "cut-off" along the edges of the template tile. Continue to duplicate markers until the pattern is complete.

5 — MODIFY THE MARKERS TO CREATE A SEAMLESS FILL PATTERN

a) Color a few of the markers on the right side and bottom of the tile (Figure 5a).

b) Inspect how the pattern is drawn in the main ArcMap window (Figure 5b).

c) Adjust the pattern using the Marker Editor and inspect it again (Figure 5c).

d) Adjust the size and the X and Y values of the marker symbol (Figure 5d).

e) Continue making adjustments until the fill displayed is completely seamless and uniform (Figures 5e1, 5e2, and 5e3).

f) Remove the stroke layer from the representation rule (Figure 5f).

6 — SAVE THE REPRESENTATION RULE AS PART OF A STYLE FILE

a) Save the representation rule (Figure 6a).

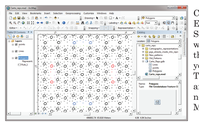
b) Use the Style Manager and Marker Editor to create the other three color variations of pattern 416 (Figure 6b).

d) Fill in the Category and Tags text boxes for each rule (Figure 6c).

5a

Coloring a few symbols on the side and bottom of the tile will make gaps and overlaps easier to locate.

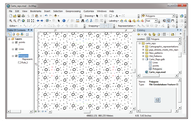
5b



Click OK back through the Marker Editor, Representation Marker Selector, and Layer Properties window. Use the Zoom In tool on the Layout toolbar to zoom to where you can view at least one whole tile. The rows of large open circles that are colored red and blue clearly need to be removed. Use the Marker Editor to delete them.

Note:
Printing the pattern from Layout View will also help determine where portions overlap or have gaps.

5c

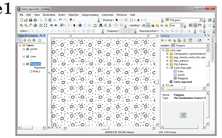


Once the colored open circles are removed, the pattern looks better, but still isn't perfectly seamless. The gap between tiles is still too wide.

5d

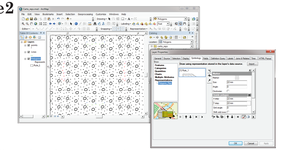
To adjust the gap, in the Layer Properties window, change the size of the marker to 22 mm (remember, this is the exact size of the FGDC tile we started with). Set the X step and Y step values to 21 mm. These values are just a starting point and may need to be adjusted later.

5e1



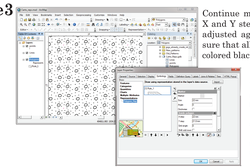
The spacing between rows of open circles now looks great, but some of the dots along the edge need to be deleted or moved. Use the colored dots as a spatial reference and make the necessary changes using the Marker Editor.

5e2



If enough markers are removed, you will need to adjust the X and Y step values. This is also a good time to print out a test page from Layout View. It is easier to see gaps and lineations in a pattern when it is printed out.

5e3



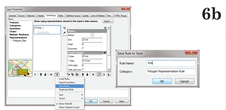
Continue making adjustments. The X and Y step values may need to be adjusted again. When finished, be sure that all the marker symbols are colored black.

Tip:
Changes made in the Marker Editor are not saved to the representation rule in the geodatabase until you click OK on the Representation Marker Selector and click Apply (or OK) on the Layer Properties window. Be sure to save your modifications often.

5f

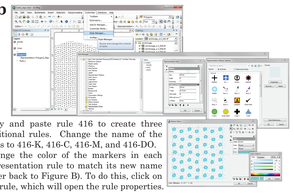
In the Layer Properties window, there are two symbol layers. Select the top stroke (line) layer. This is what gives the polygon a border. Since there is a separate ContactsAndFaults feature class, it needs to be removed. With the stroke layer selected, click the Remove Layer button.

6a



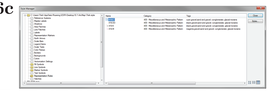
Under Rule Options, click Save Rule to bring up the Save Rule to Style Window. Save the rule as 416. The rule will be saved in your personal style file on your computer.

6b



Copy and paste rule 416 to create three additional rules. Change the name of the rules to 416-K, 416-C, 416-M, and 416-DO. Change the color of the markers in each representation rule to match its new name (refer back to Figure B). To do this, click on the rule, which will open the rule properties.

6c



Fill in the Category and Tags text boxes for each rule. The text in these boxes can be used to search for specific patterns in the Representation Rule Selector. The category corresponds to the FGDC Pattern Chart. In this case, series 400 – Miscellaneous and Metamorphic Pattern. Tags should include the color and the common geologic uses as listed in the Selection of Colors and Patterns for Geologic Maps of the U.S. Geological Survey Techniques and Methods 11-B1 manual.

CONCLUSION

The creation of patterns as cartographic representations can be a tedious and time consuming task. It can take up to several hours to create and perfect each pattern. However, once a pattern exists as a representation rule, it will never need to be re-created again. Patterns stored in a style file can be re-used and shared for a variety of purposes. Patterns as cartographic representations are clear and consistent, regardless of map scale. As representations, the patterns are stored in the geodatabase with the map data. This eliminates the need to constantly reassign symbology. Pattern fill representations enhance the readability of maps, lend additional geologic information to users and can be shared as part of a dataset.

REFERENCES

Federal Geographic Data Committee [prepared for the Federal Geographic Data Committee by the U.S. Geological Survey], 2006, FGDC Digital Cartographic Standard for Geologic Map Symbolization: Reston, Va., Federal Geographic Data Committee Document Number FGDC-STD-013-2006, 290p., 2 plates.
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