

DIGITAL MAPPING TECHNIQUES 2013

The following was presented at DMT'13
(June 2-5, 2013 - Colorado Geological Survey and Colorado School of Mines
Golden, CO)

The contents of this document are provisional

See Presentations and Proceedings
from the DMT Meetings (1997-2013)

<http://ngmdb.usgs.gov/info/dmt/>

Creating Patterns as Cartographic Representations for Geologic Maps

By Patricia E. Gallagher

Alaska Division of Geological & Geophysical Surveys (DGGS)
3354 College Road
Fairbanks AK 99709-3707
Telephone: (907) 451-5039
Fax: (907) 451-5050
email: patricia.gallagher@alaska.gov

ABSTRACT

This tutorial teaches ArcGIS users how to create crisp, clear, and consistent patterns as cartographic representations for use on geologic maps. Patterns are created from scratch using the Marker Editor and are compliant with Federal Geographic Data Committee (FGDC) and U.S. Geological Survey (USGS) cartographic standards for geologic map symbolization. For more information, contact Patricia Gallagher. This information was presented at the DMT'13 meeting as an oral presentation and as a poster; see

http://ngmdb.usgs.gov/Info/dmt/DMT_presentations.html#dmt13

INTRODUCTION

Geologic maps are often admired not only as useful scientific tools, but as works of art in their own right. A geologic map's many colors and patterns contribute to this characterization. Colors and patterns enhance the legibility of a map and lend meaning to the data being presented. Patterns, although less pervasive than colors, help maintain the basic color scheme on complex maps, enhance the differences between geologic units with similar colors, and provide additional information about the physical characteristics of a rock (Figure 1). Patterns are most often used for surficial (unconsolidated sediments that make up landforms), igneous, and volcanic units.

In the past, choices for geologic patterns in ArcMap were limited by the use of traditional symbology. The Esri "Geology 24K" style file released with the ArcMap software contains only 35 picture fill symbols. The Geology 24K picture fill patterns are pixelated when applied to a map. In contrast, patterns created using marker symbols within a representation rule are clear, crisp, and consistent at any scale (Figure 2). This exercise will detail how to create a pattern as a cartographic representation rule.

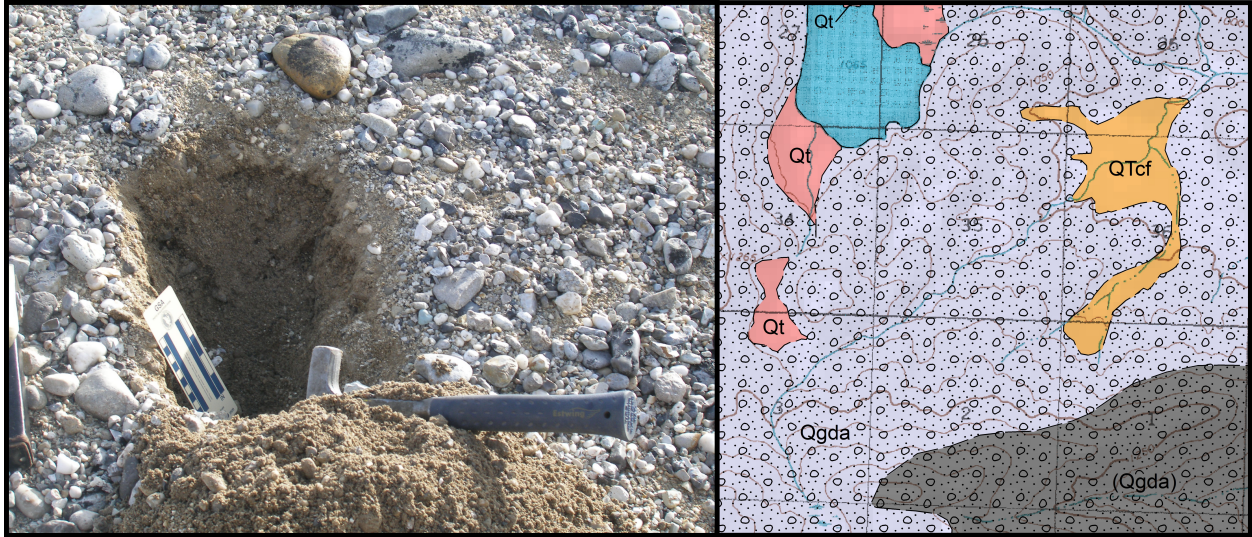


Figure 1. Coarse sand and gravel deposited by a stream, as seen on the ground (left), and as represented on a geologic map (right). Photo by Trent Hubbard.

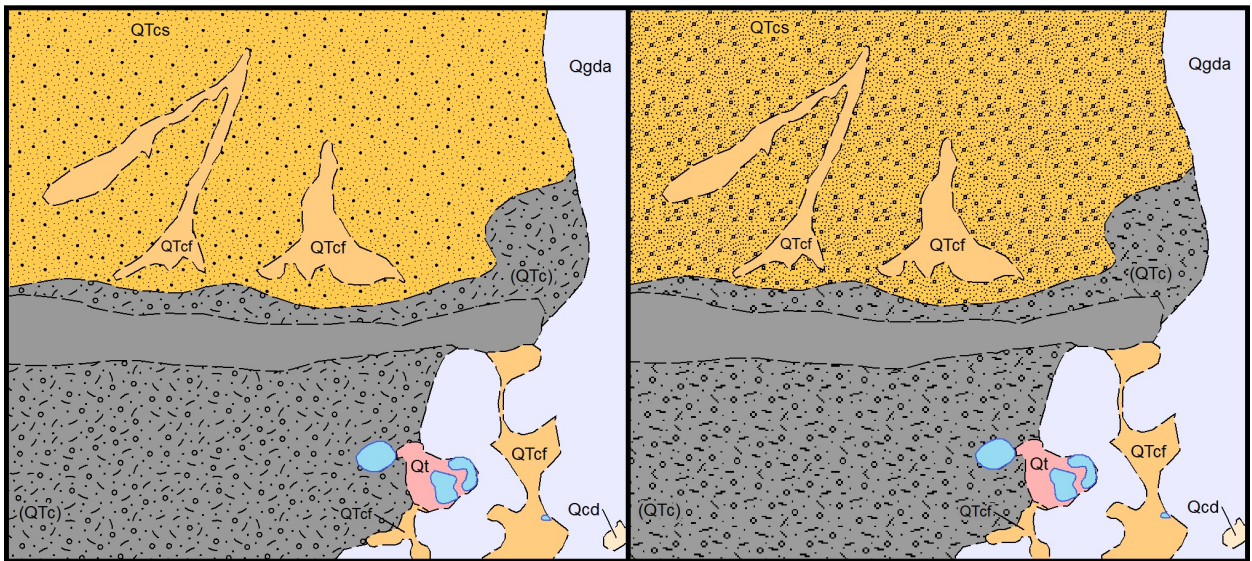


Figure 2. Geologic patterns as cartographic representations (left) and as picture fill symbols from the Esri Geology 24K style file (right).

GETTING STARTED

Certain patterns have a particular meaning for geologists. Stipple and circular patterns are generally used to show surficial deposits, with the spacing of the stipples corresponding to the relative size and character of the material being represented. For example, a fine stipple pattern would be used for sand while a coarser stipple pattern would be used for coarse gravel. The

Selection of Colors and Patterns for Geologic Maps of the U.S. Geological Survey Techniques and Methods 11-B1 manual shows patterns that are most frequently used by the USGS. For this exercise, pattern 416 will be created in ArcMap. In the 11-B1 manual, pattern 416 is generally used to show gravel, sand and gravel, conglomerate, and glacial moraine deposits (Figure 3). Pattern 416 can also be found in the Federal Geographic Data Committee (FGDC) Pattern Chart (Figure 4). This chart identifies pattern 416 as a miscellaneous or metamorphic design that is in the 400 series and is acceptable in 4 different color configurations—black (K), cyan (C), magenta (M), and dropout (DO).

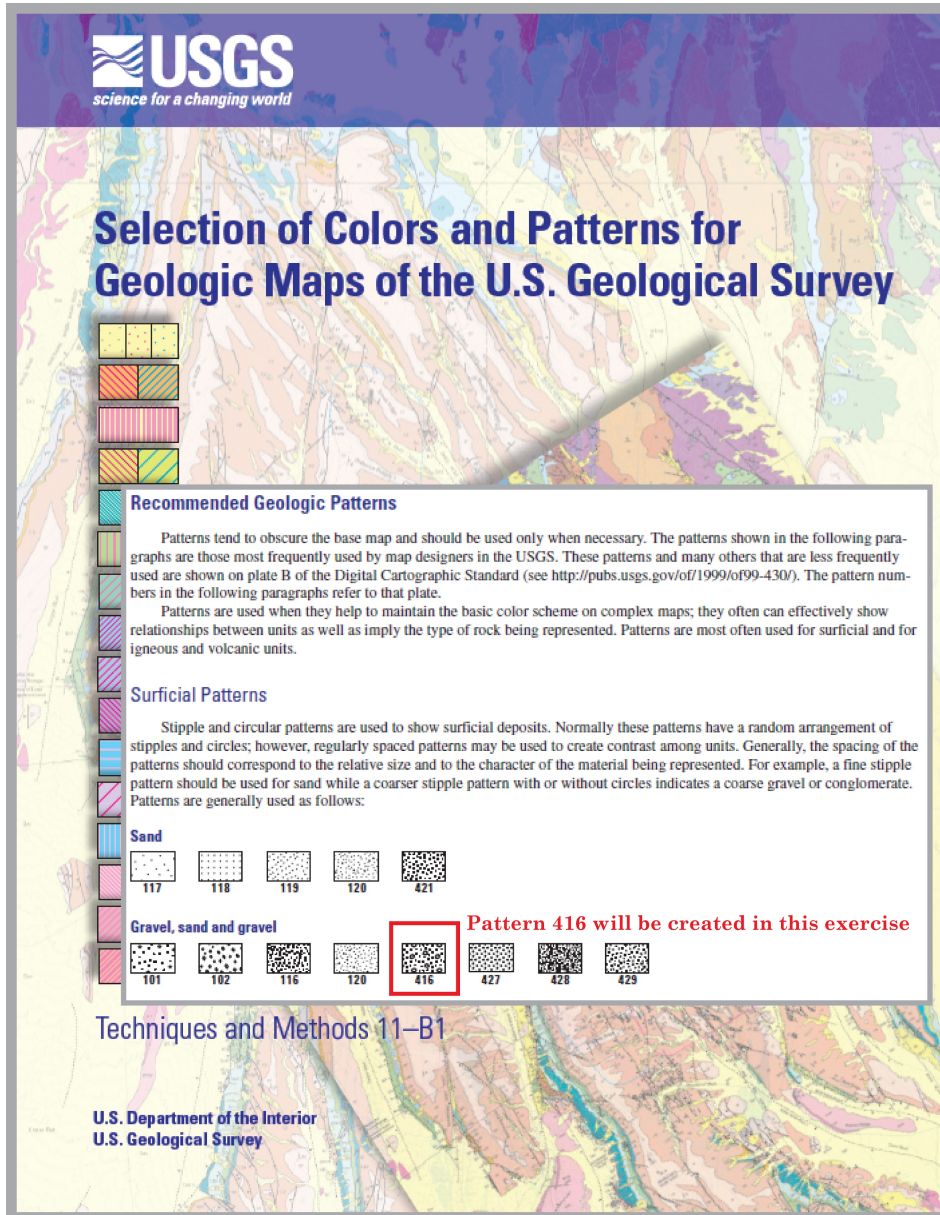


Figure 3. The Selection of Colors and Patterns for Geologic Maps of the U.S. Geological Survey Techniques and Methods 11-B1 manual shows patterns that are most frequently used by the USGS. Pattern 416 is generally used to show gravel, sand and gravel, conglomerate, and glacial moraine deposits.

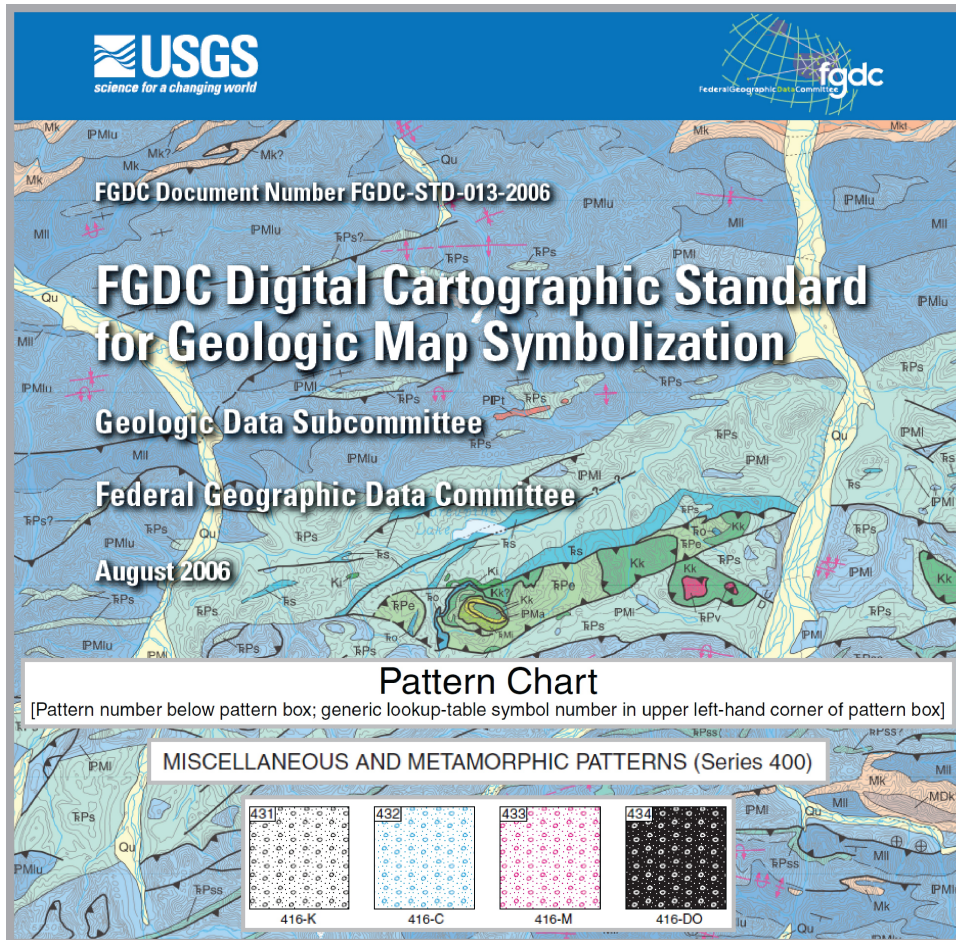


Figure 4. The Federal Geographic Data Committee (FGDC) Standard for Map Symbolization, showing a portion of the Pattern Chart. Pattern 416 is considered a miscellaneous or metamorphic pattern that is in the 400 series and is acceptable in four different color configurations—black (K), cyan (C), magenta (M), and dropout (DO).

HOW TO CREATE A PATTERN AS A CARTOGRAPHIC REPRESENTATION RULE

Create a “Template Tile” in Adobe Illustrator

Most FGDC patterns were designed using Adobe Illustrator 8.0 to closely replicate patterns in the informal Technical Cartographic Standards volume. An Adobe Illustrator swatch library containing pattern swatches is available for download at: <http://pubs.usgs.gov/tm/2006/11A02/>

The first step when creating a 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 (Figure 5).

1. Open Adobe Illustrator and create a new artboard. On the Standard Menu, choose File > New. In the New Document window, specify that the artboard will be 22 mm wide and 22 mm tall. These are the exact dimensions of the pattern tiles on the FGDC Pattern Chart.

2. Open the FGDC swatch library. Under the Swatches tab, choose Swap Libraries > Other Library. Navigate to, and select, the FGDC swatch library that was downloaded from the USGS.
3. Use the rectangle tool to draw a rectangle that covers the entire artboard. On the path toolbar at the top of the window, change the stroke width to 0 pt.
4. Select pattern 416-M from the FGDC swatch library. Choose 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. Use the fill symbol dropdown box on the path toolbar at the top of the window to choose pattern 416-M.
5. Export the artboard as a PNG file. Choose File > Export. Select PNG from the Save as type dropdown list. Name the file 416. When you click Save, a PNG Options window will appear. Choose High (300ppi) resolution, no antialiasing, and a transparent background color. These options will speed up draw time when using the template tile in the ArcMap Representation Marker Editor.

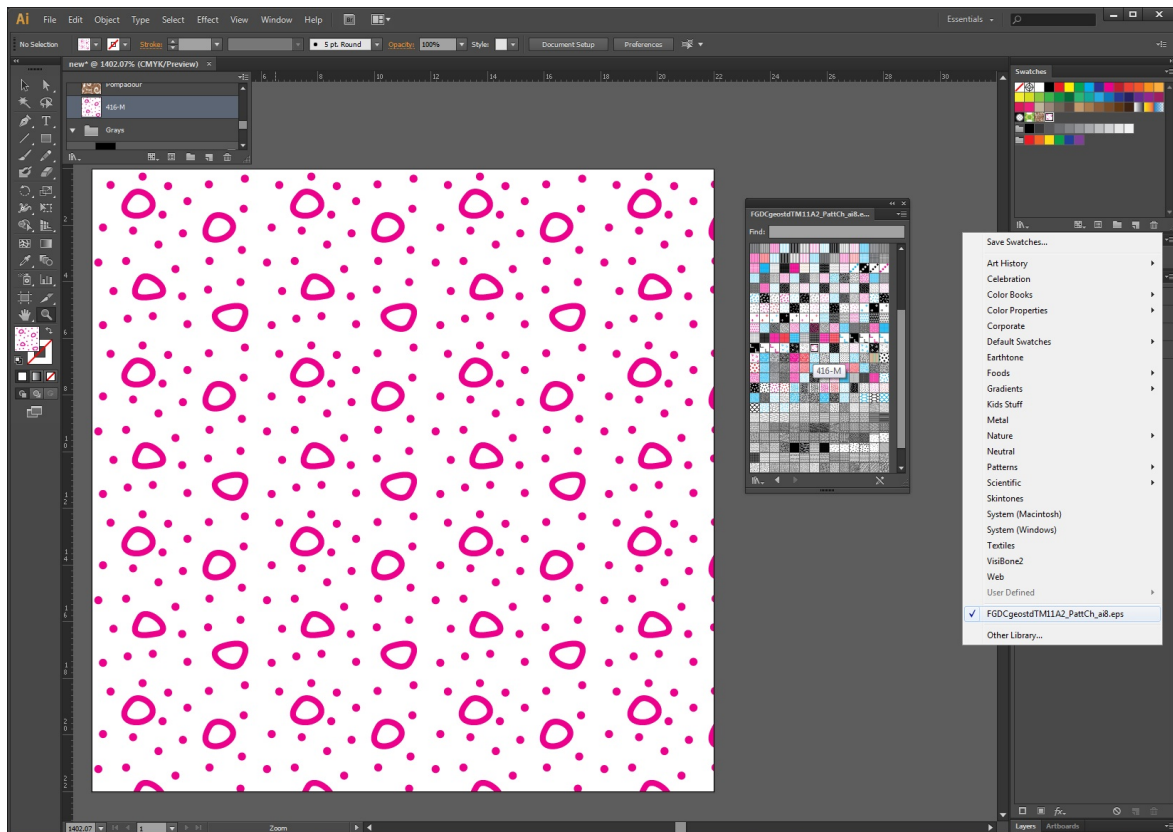


Figure 5. Create a 22 mm square “template tile” of the pattern using Adobe Illustrator and the FGDC swatches.

Transform the Template Tile into a Cartographic Representation Rule

It is useful to create a new geodatabase that contains a simple polygon feature class when creating cartographic representations from scratch. Create one simple polygon in the feature class. Draw time for complex patterns is improved when using only a single polygon.

1. Symbolize the polygon in the feature class using the Symbology tab in the Layer Properties dialog box. Symbolize the layer as a single symbol. Click the colored rectangle to access the Symbol Selector. Click Edit Symbol. Choose Picture Fill Symbol from the Type dropdown list. Navigate to, and open the PNG file that was saved in the earlier step.
2. In the Table of Contents, right-click on the polygon feature class. Select Convert Symbology to Representation. Click Convert to translate the picture symbol to a representation marker.

Customize the Representation Rule

1. 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. Open the Marker Editor by clicking the Properties button (Figure 6).
2. Zoom in on a few of the symbols and use the drawing tools to create a dot and an open circle and place them over the template tile. Use the Create Circle drawing tool to create the dot marker. Use the Create Line tool to make the large open circle marker. Adjust the line width of the circle marker and the size of the dot marker to be roughly half the thickness of the magenta symbols in the template tile.
3. Copy and paste the markers and drag them to the remaining magenta template markers. The open circles may need to be rotated at various angles to match. 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 (Figure 7). 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.
4. Once all of the markers are placed, select the template tile and delete it.

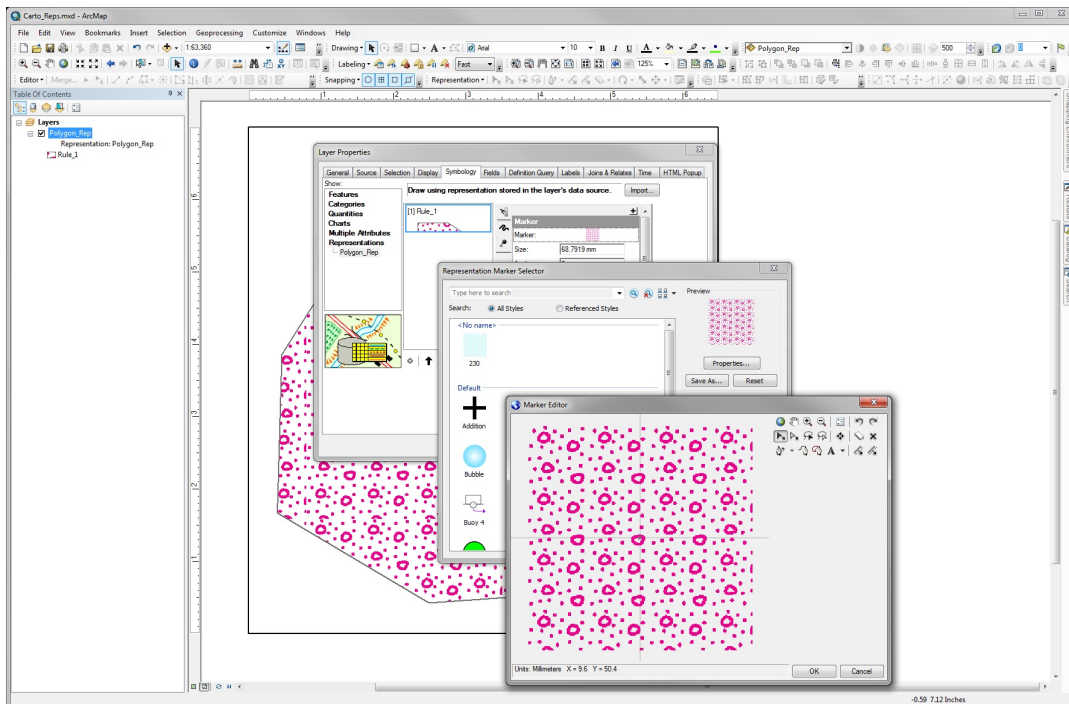


Figure 6. Use the template tile to symbolize a polygon, then convert symbology to representation and open the Marker Editor.

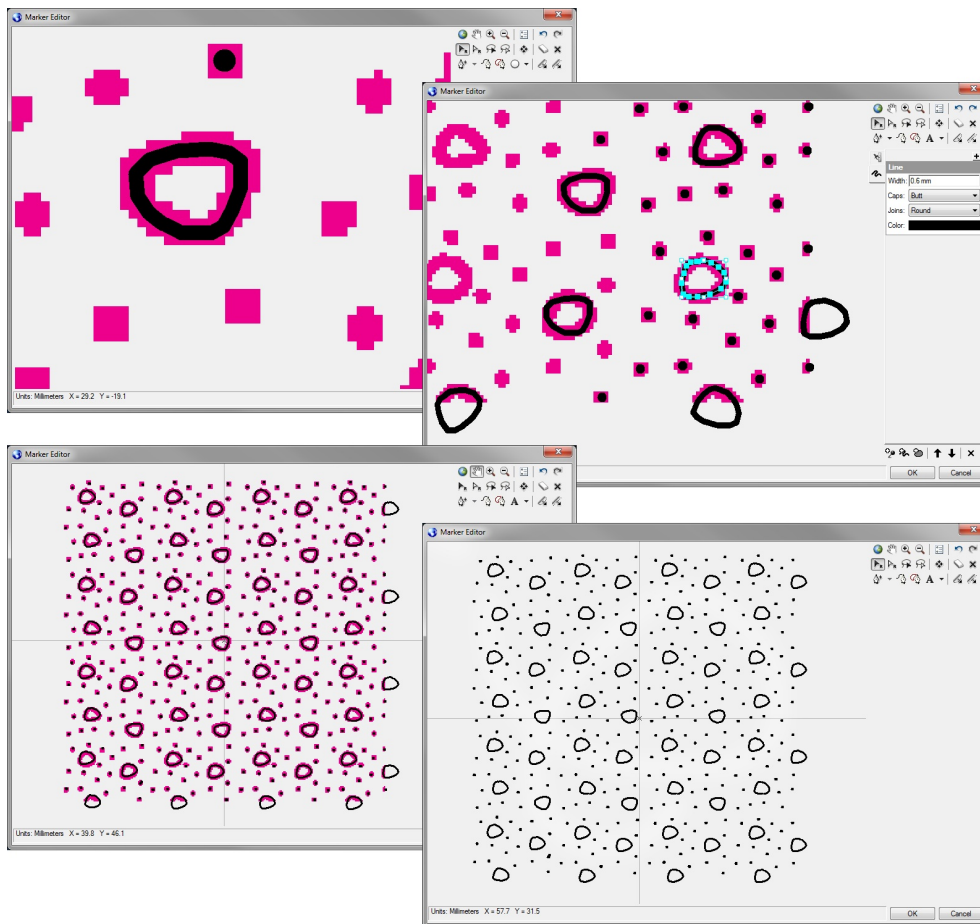


Figure 7. Create markers, place them over the template tile, and delete the template tile.

Modify Markers to Create a Seamless Fill Pattern

1. Using the Marker Editor, color a few of the markers on the right side and bottom of the tile. The colored markers will make gaps and overlaps between tiles easier to locate (Figure 8).
2. Click OK back through the Marker Editor, Representation Marker Selector, and Layer Properties window. Inspect how the pattern is drawn in the main ArcMap window. Use the Zoom In tool on the Layout toolbar to zoom to where you can view at least one whole tile. Identify which markers need to be removed and use the Marker Editor to delete them. Printing the pattern from Layout View will also help determine where portions overlap or have gaps.
3. Once the colored open circles are removed, inspect the pattern again. At this point, the pattern will probably look better, but may not be perfectly seamless. There will likely be a gap between tiles. On the symbology tab of the Layer Properties window change the size value of the marker to 22 mm (remember, this is the exact size of the FGDC tile we started with). Next, change the Inside polygon X and Y step values to 21 mm. These step values are just a starting point and may need to be adjusted later (Figure 9).

4. Continue making adjustments using the Marker Editor and Marker Properties until the pattern displayed is completely seamless and uniform. Keep in mind that 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. When finished, color all the marker symbols black.
5. Remove the stroke layer from the representation rule. In the Layer Properties window, there are two symbol layers. Select the top stroke (line) layer. This is what gives the polygon a border. With the stroke layer selected, click the Remove Layer button.

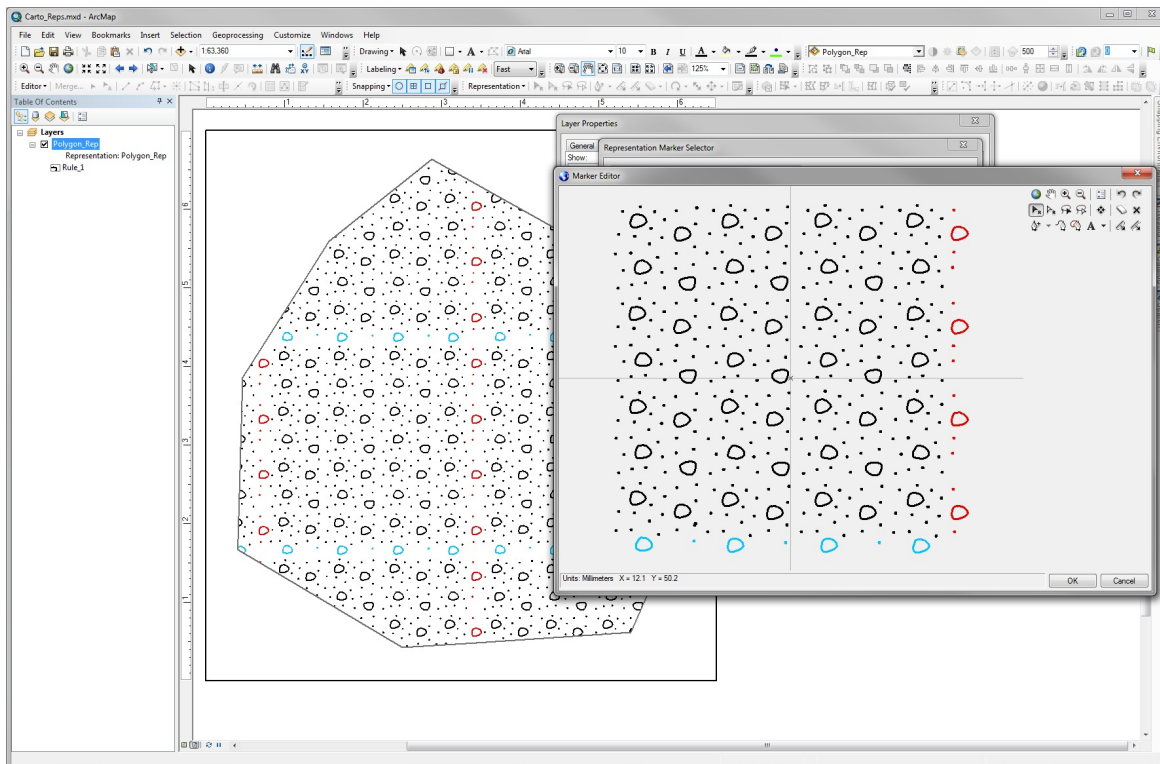


Figure 8. Use colored markers to identify gaps and overlaps in the tiled pattern.

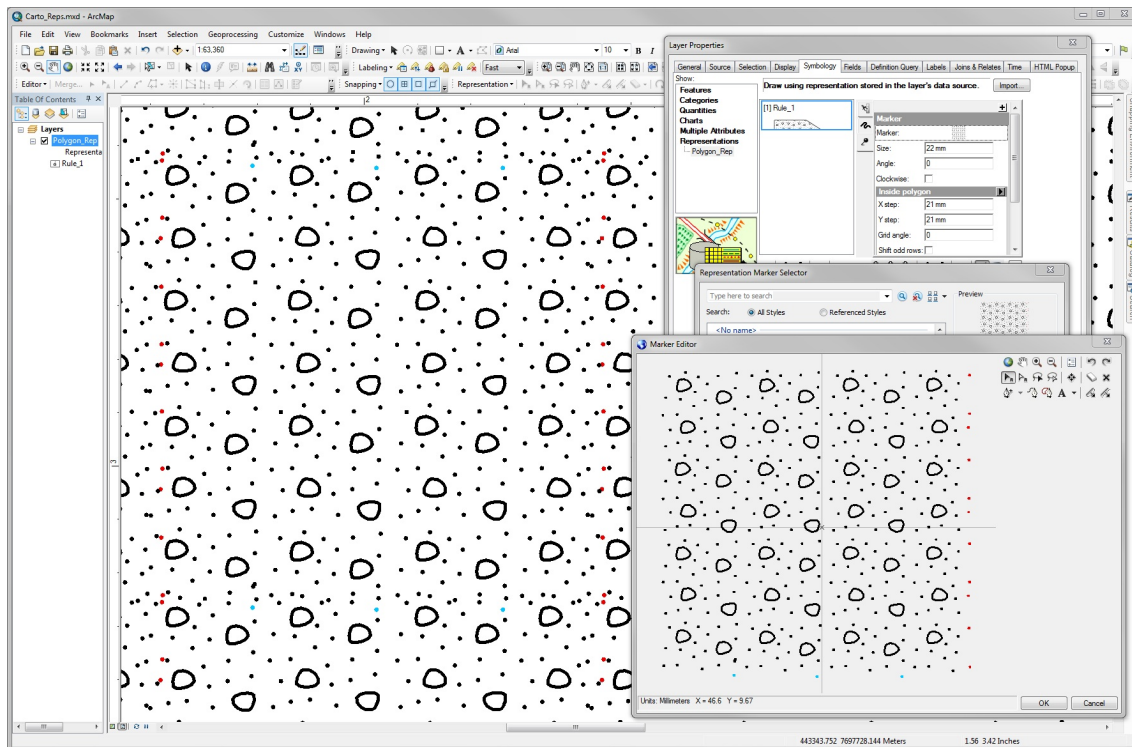


Figure 9. Adjust the size, X step, and Y step of the marker properties. Continue resolving gaps and overlaps in the tiled pattern.

Save the Representation Rule as Part of a Style File

1. Under Rule Options, click Save Rule to bring up the Save Rule to Style Window. Save the rule as 416 (Figure 10). The rule will be saved in the personal style file on your computer. Once the rule is saved, click OK on the Layer Properties window.
2. Choose Customize > Style Manager and open the personal style file folder and Representation Rules folder to which the rule was just saved. 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.
3. Double click on each rule to bring up the Representation Rule properties window and continue to the Marker Editor. Change the color of the markers in each representation rule to match its new name (K=100% black, C=100% cyan, M=100% magenta, and DO=no color/white) (Figure 11).
4. 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 series as shown on the FGDC Pattern Chart. Tags should include the color and the common geologic uses as listed in the USGS TM 11-B1 manual. In the case of pattern 416, the category is 400—Miscellaneous and Metamorphic Pattern and the tags are gravel, sand and gravel, conglomerate, and glacial moraine.

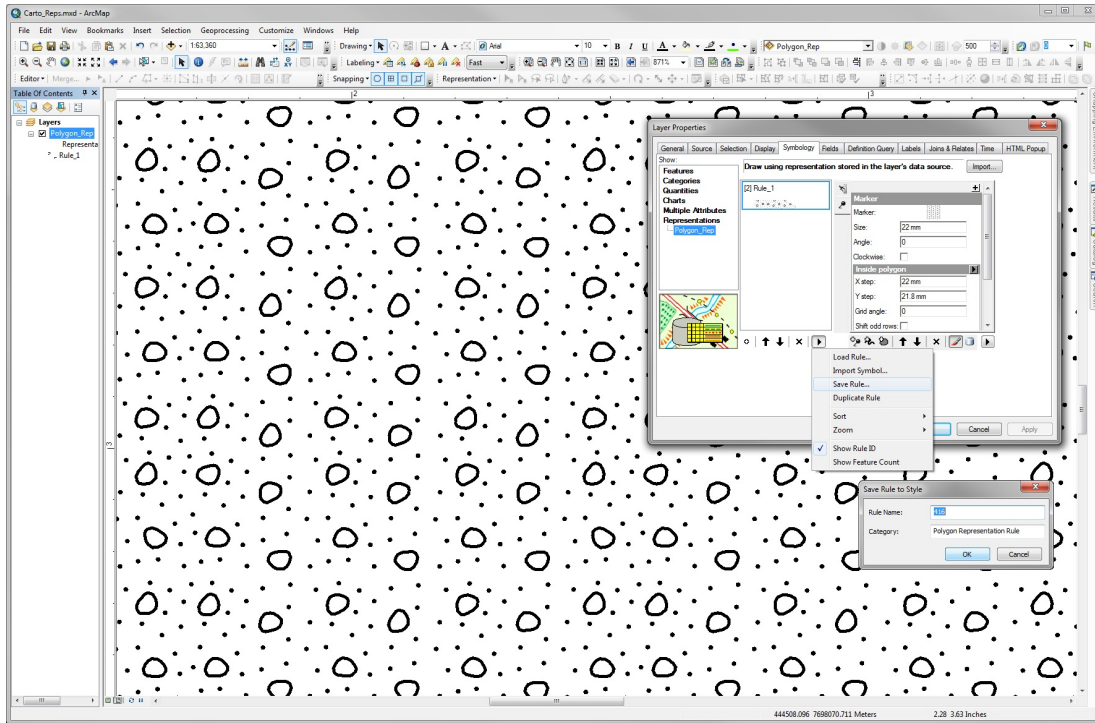


Figure 10. When the pattern is complete and tiles seamlessly, save the rule to a style file.

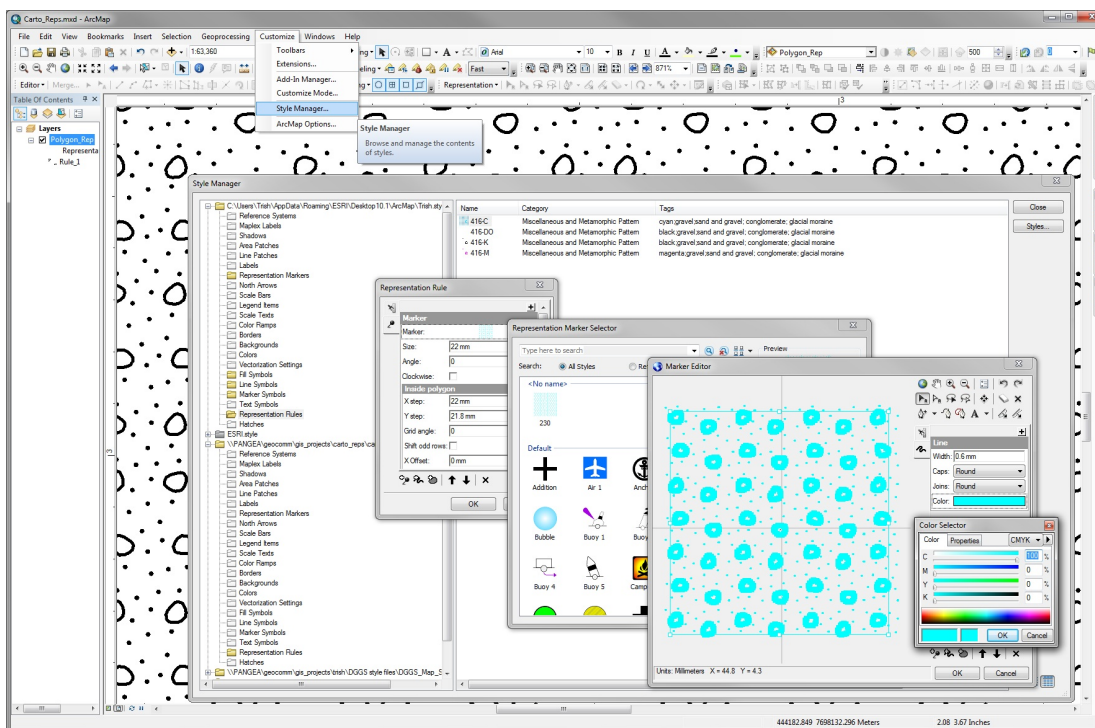


Figure 11. Use the Style Manager to duplicate, modify, and tag representation rules according to the FGDC standards.

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. 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. Currently, the Alaska Division of Geological & Geophysical Surveys (DGGS) has a style file containing 23 pattern fills as representation rules. Please contact Patricia Gallagher if you would like a copy of the style file to use in your organization's projects.

ACKNOWLEDGMENTS

Thanks again to Dave Soller and the folks at the USGS for standardizing and creating the pieces and parts needed to complete the pattern-making process. Special thanks to Jim Weakland, Paula Davis, and DGGS staff for their support and encouragement in pursuing this project.

RESOURCES AND HELPFUL LINKS

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, 290 p., 2 plates. <http://www.fgdc.gov/standards/projects/FGDC-standards-projects/geo-symbol>

U.S. Geological Survey, 2005, Selection of colors and patterns for geologic maps of the U.S. Geological Survey: Techniques and Methods 11-B1, 19 p.; 1 plate. <http://pubs.usgs.gov/tm/2005/11B01/>

U.S. Geological Survey, 2006, FGDC Digital Cartographic Standard for Geologic Map Symbolization (PostScript Implementation): U.S. Geological Survey Techniques and Methods 11-A2. <http://pubs.usgs.gov/tm/2006/11A02>