Creating FGDC-Compliant Cartographic Representations

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Overview of Presentation

- DGGS inclusion of USGS suggested colors into style file
- Cartographic representations and their benefits
- Translating traditional symbols into representations
- Creating pattern fill representations from scratch
- Concerns about the TM 11-B1 manual and FGDC pattern chart

USGS
science for a changing world

Suggested Colors for Geologic Maps

[This color chart shows suggested colors for different geologic ages, as well as colors for igneous and metamorphic rocks. Numbers below each color box are CMYK color codes, as follows: A = 0%, 1 = 15%, 2 = 30%, 3 = 50%, 4 = 70%, 5 = 90%, 6 = 95%, 7 = 100%. Colors on this chart were chosen on the basis of how they look on printed or on offset printing press. As printed on an offset printing press, the colors conform to USGS geologic age color standards. However, if the CMYK color codes are printed on a computer-driven ink-jet plotter, some of the colors will not conform to the USGS geologic age colors. Users should be aware of this limitation and choose colors accordingly. Note that some of the dark combination colors (composed of high percentages of the four CMYK inks) are generally too dark to use for most purposes, because they can obliterate topographic base features and geologic map data. On most computer-driven plotters, some of the darkest colors on this chart will print dark gray to black.]

Quaternary
Yellows, no color
Q

Tertiary
Oranges, yellowish-oranges, tan, brown
T

Cretaceous
Yellow-greens or olive-greens
K

Jurassic
Green
J

Triassic
Blue-greens
Tr

Permian
Blue
P

Pennsylvanian
Blue-with-red
IP

Mississippian
Bluish-purple
M

Devonian
Brownish-purple
D

Silurian
Reddish-purple
S

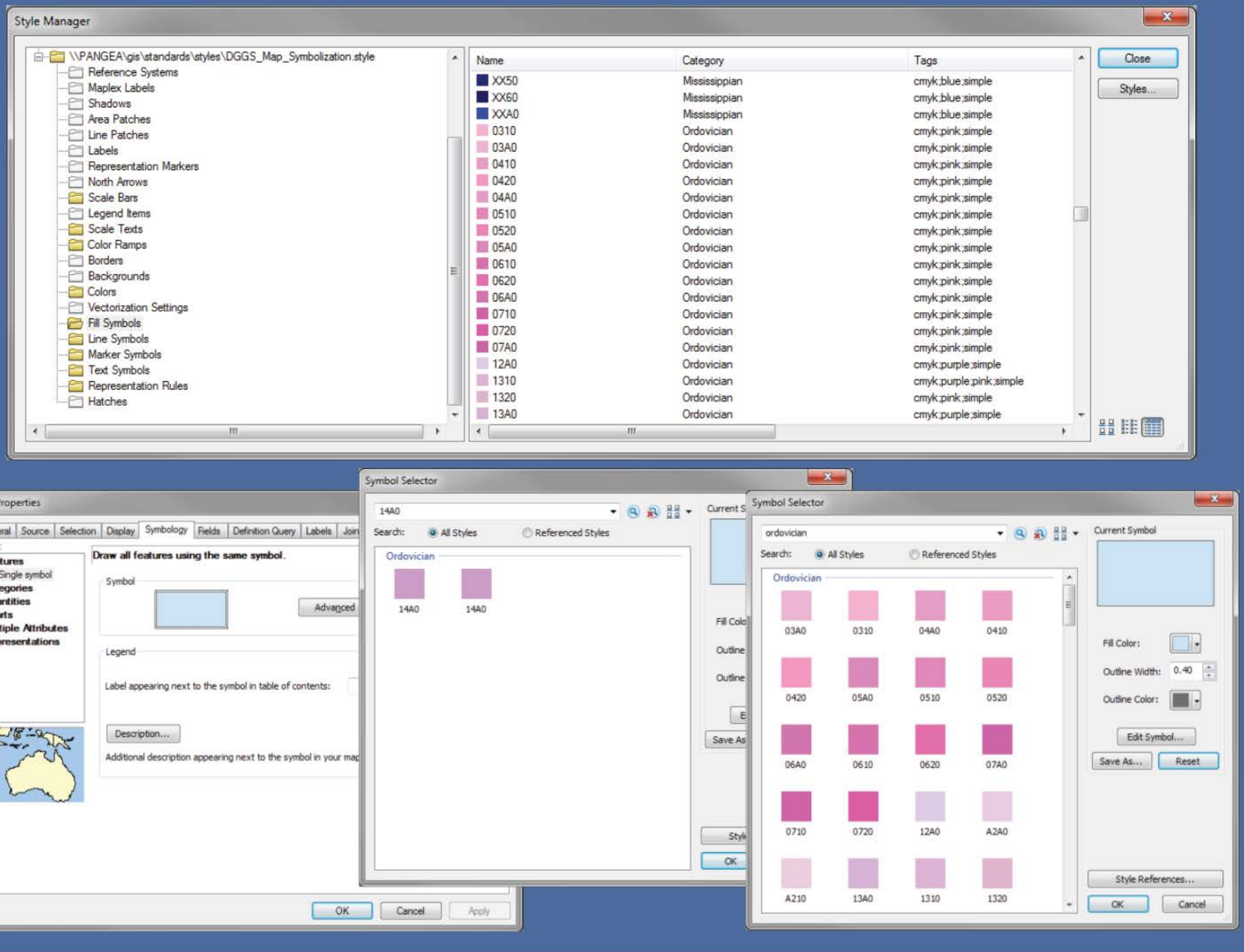
Ordovician
Reddish-red
O

Cambrian
Reddish-brown
C

Precambrian
(includes Proterozoic and Archean)
Olive-browns, olives, grays, olive-blues, reddish-olives
pC

Igneous and volcanic rocks
Red, pink, bright oranges

U.S. Department of the Interior
U.S. Geological Survey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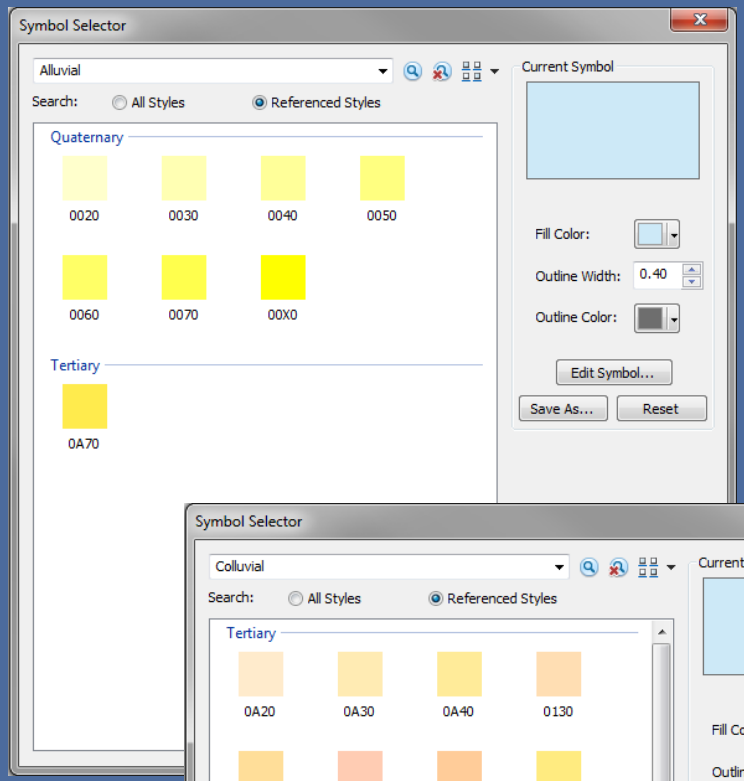
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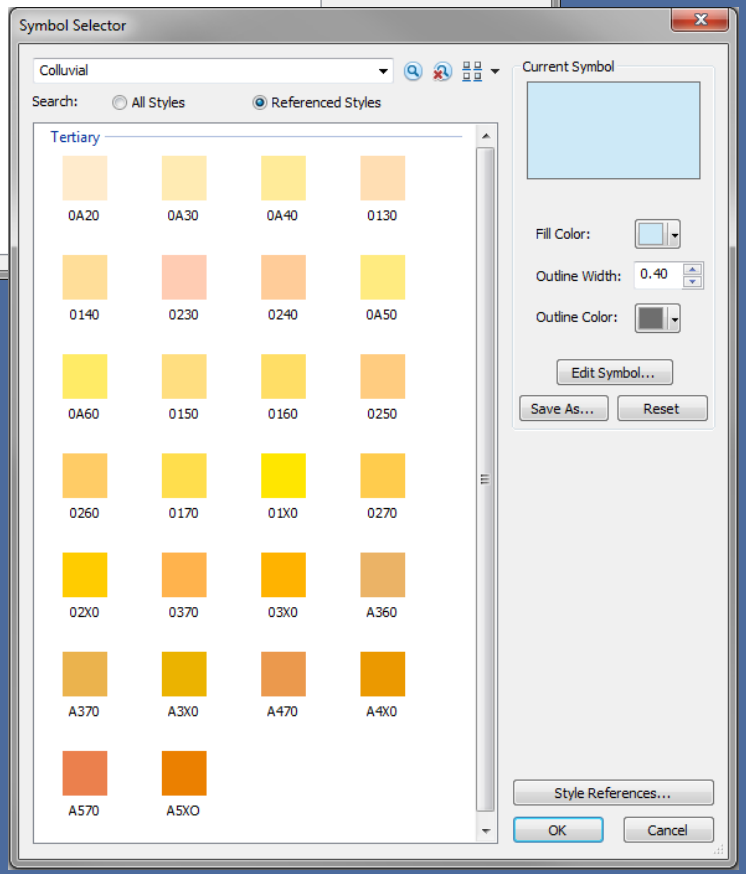
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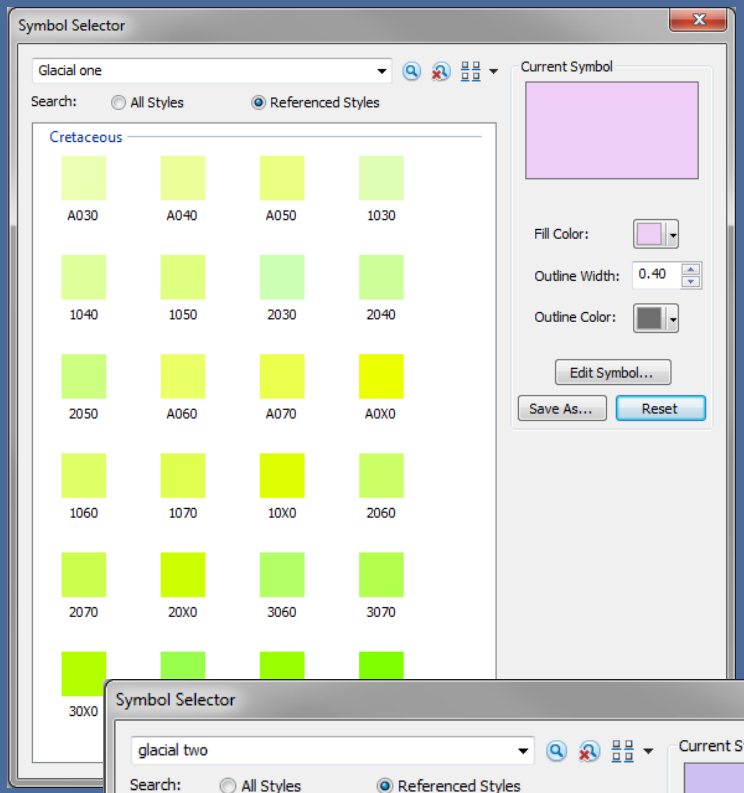
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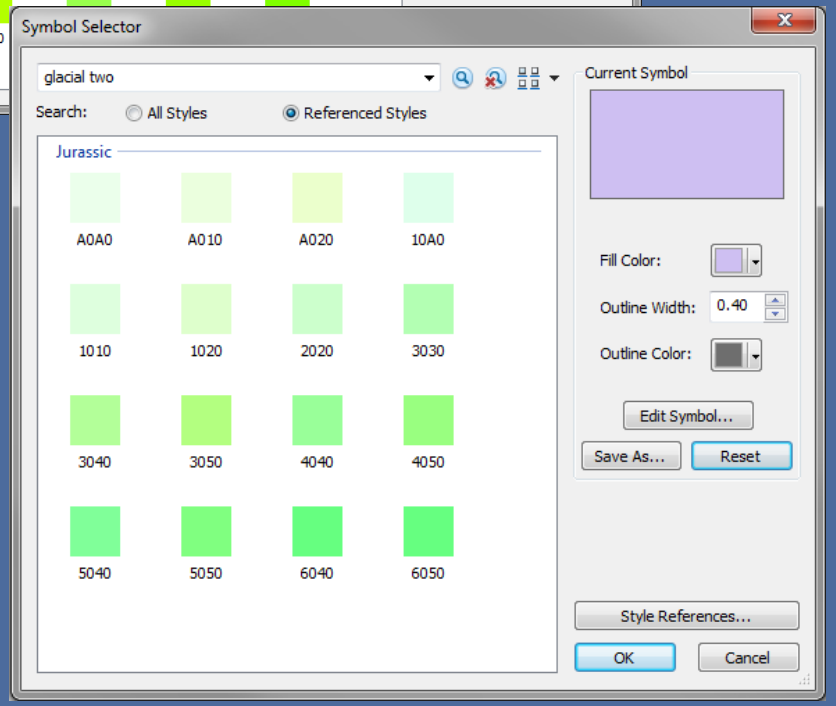
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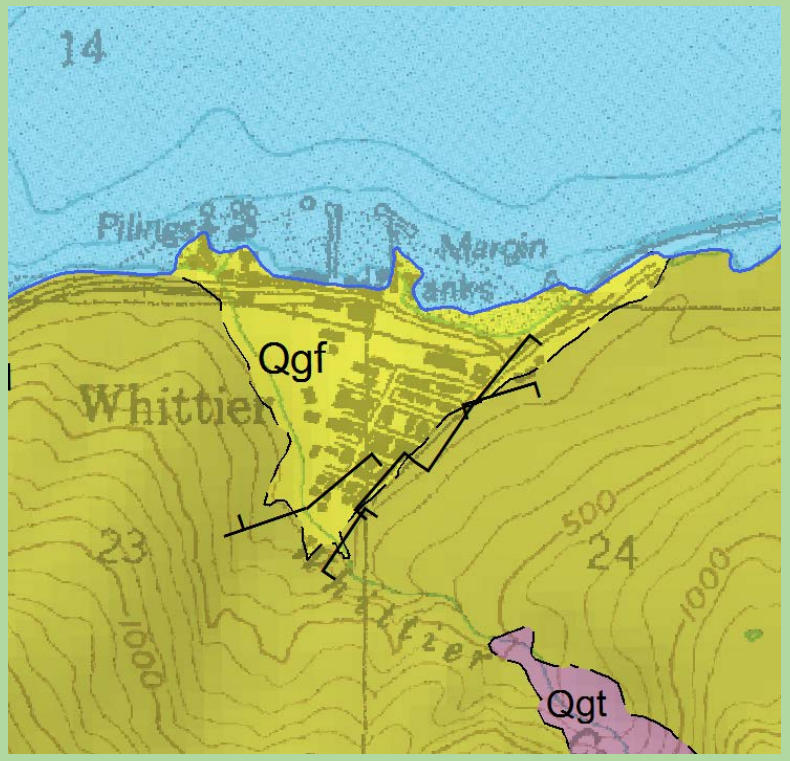
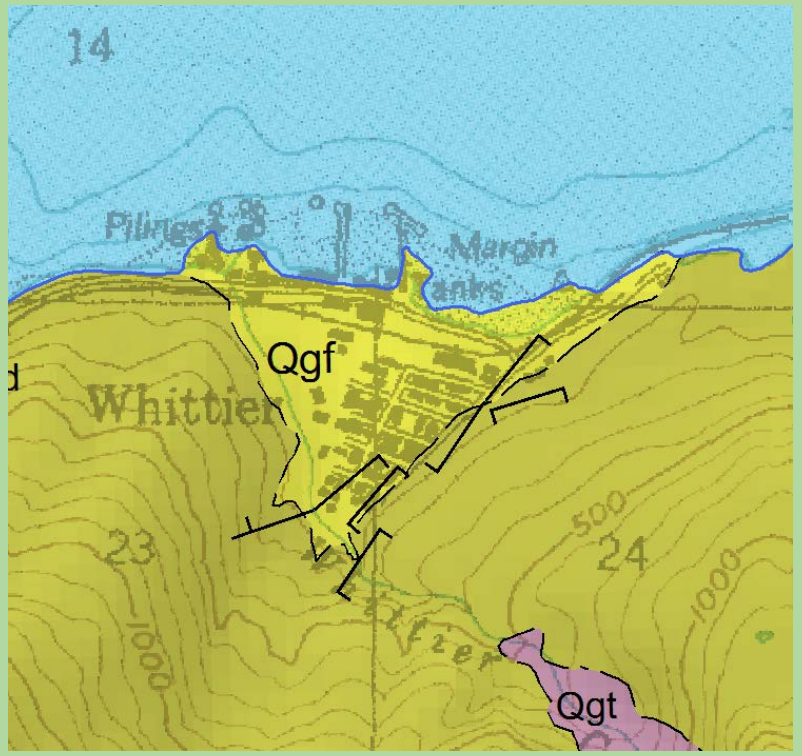
Representations Rock!

Representations help solve cartographic challenges

Provide greater flexibility and control of map symbology



Traditional Symbology

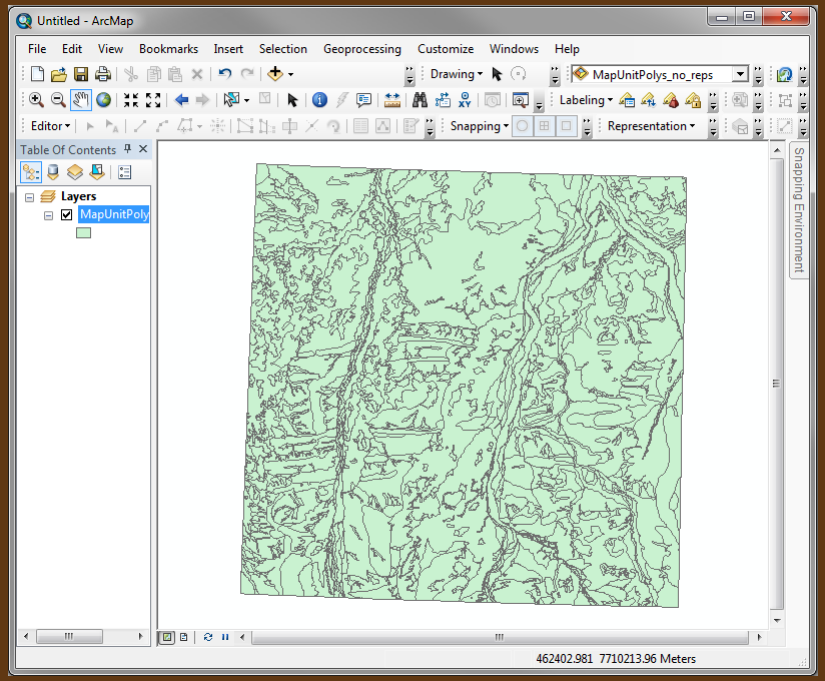


Cartographic Representations

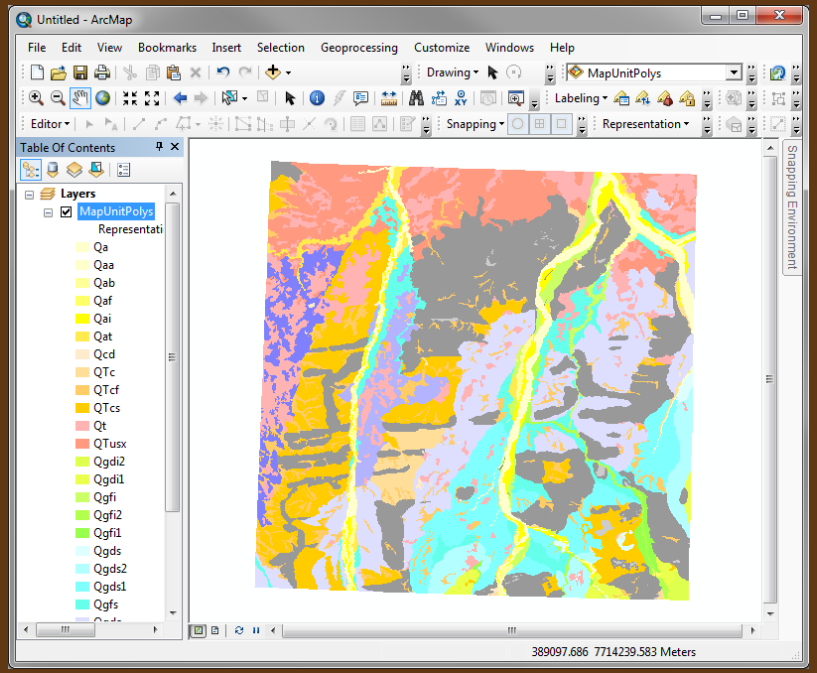
Representations Rock!

Representations help solve cartographic challenges

Store rule-based symbols in the geodatabase along with data

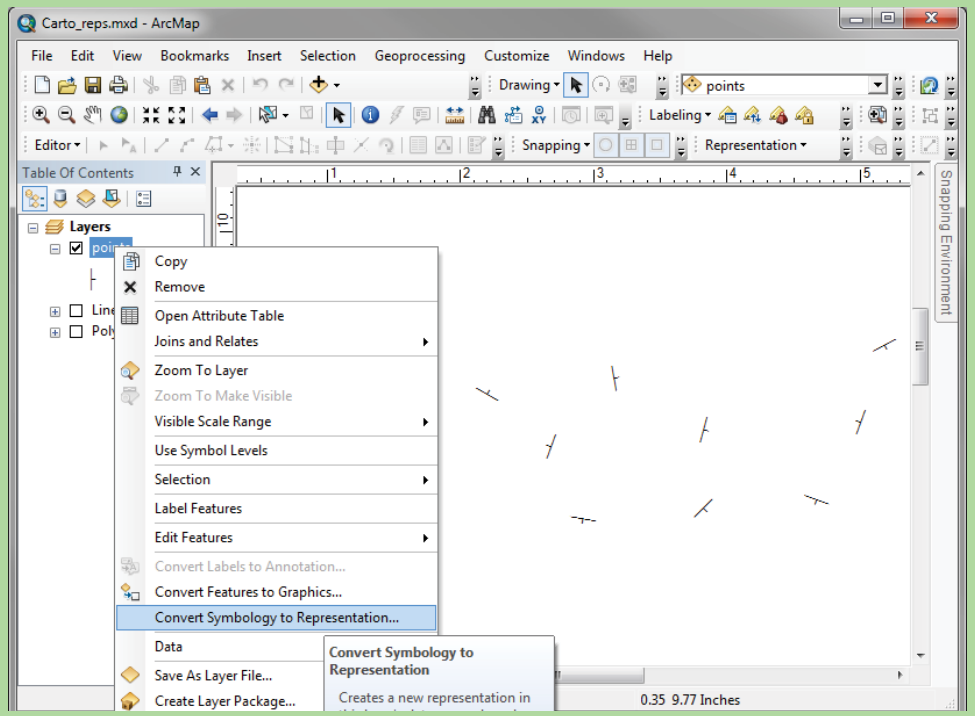


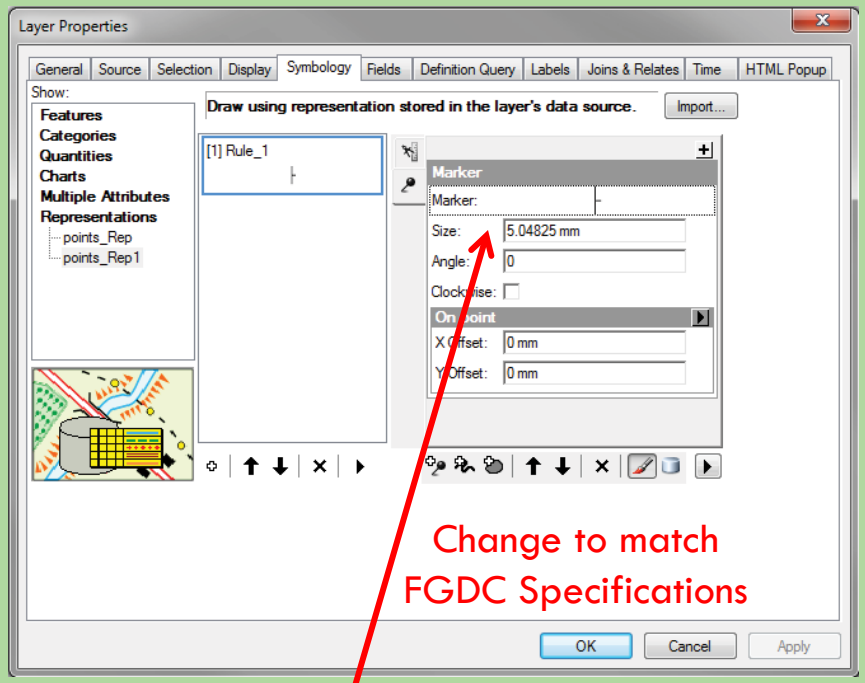
Traditional Symbology



Cartographic Representations

Translating FGDC Symbols Into Cartographic Representations





Change to match FGDC Specifications

Federal Geographic Data Committee
FGDC Digital Cartographic Standard for Geologic Map Symbolization

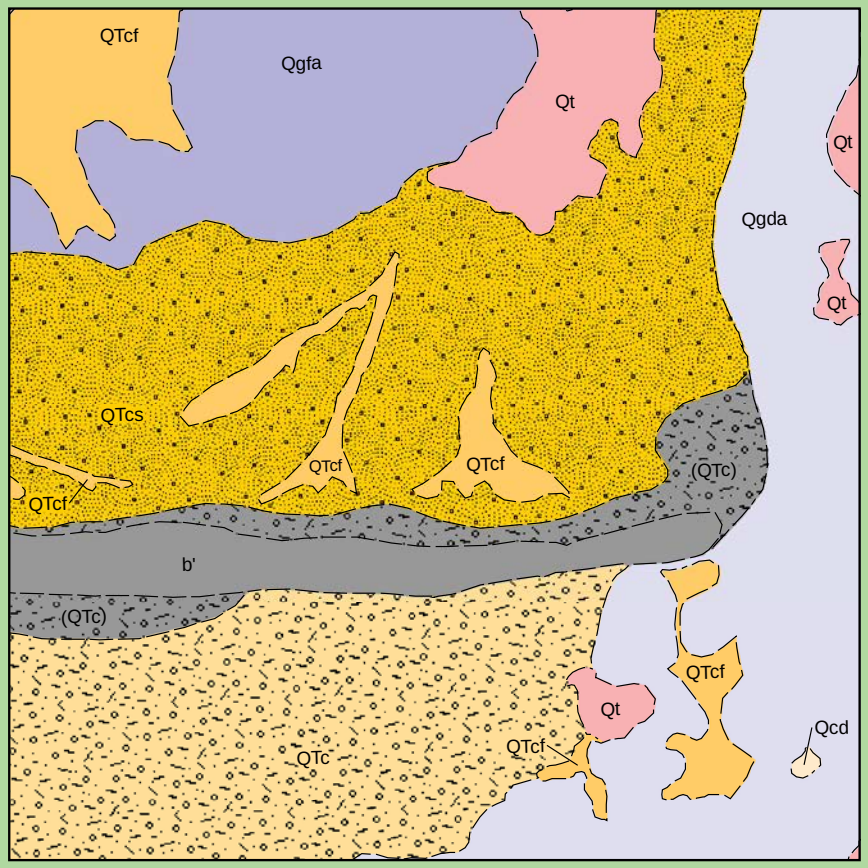
FGDC Document Number FGDC-STD-013-2006
Appendix A

6—BEDDING

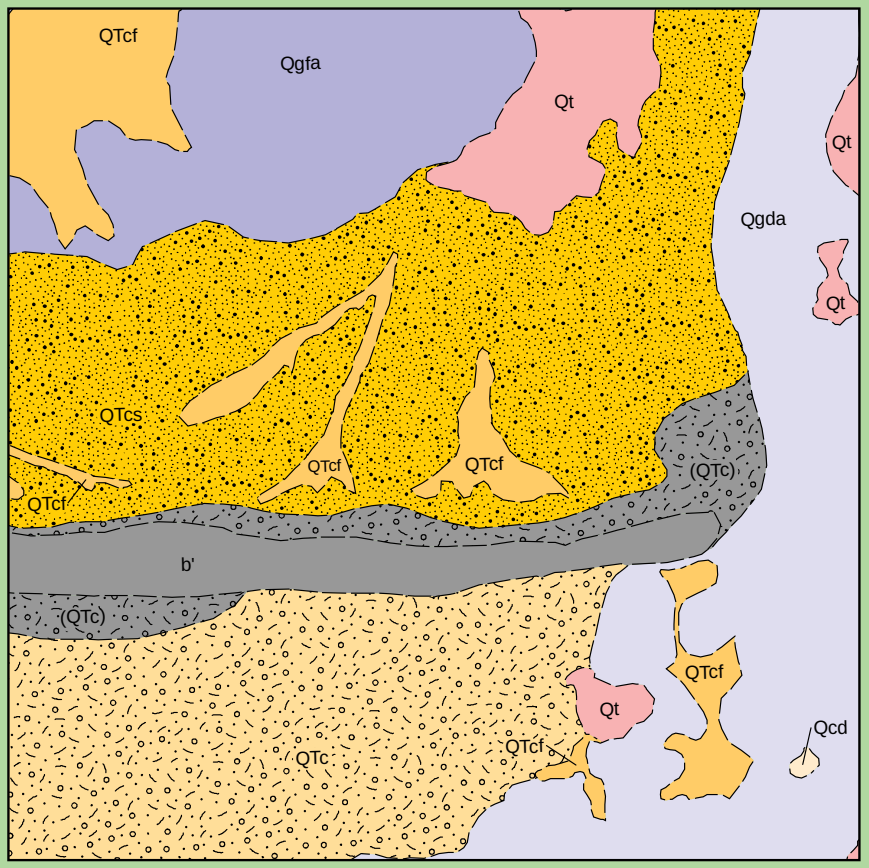
REF NO	DESCRIPTION	SYMBOL	CARTOGRAPHIC SPECIFICATIONS*	NOTES ON USAGE*
6.1	Horizontal bedding	⊕	all lineweights .2 mm; circle diameter 2.5 mm	Inclined (upright) and overturned bedding symbols are used when the top direction of beds is known to a reasonable degree of certainty. On maps where determination of top direction
6.2	Inclined bedding—Showing strike and dip	40	1.0 mm; 40; Hl-6; 5.0 mm; all lineweights .2 mm	

Patterns as Representations

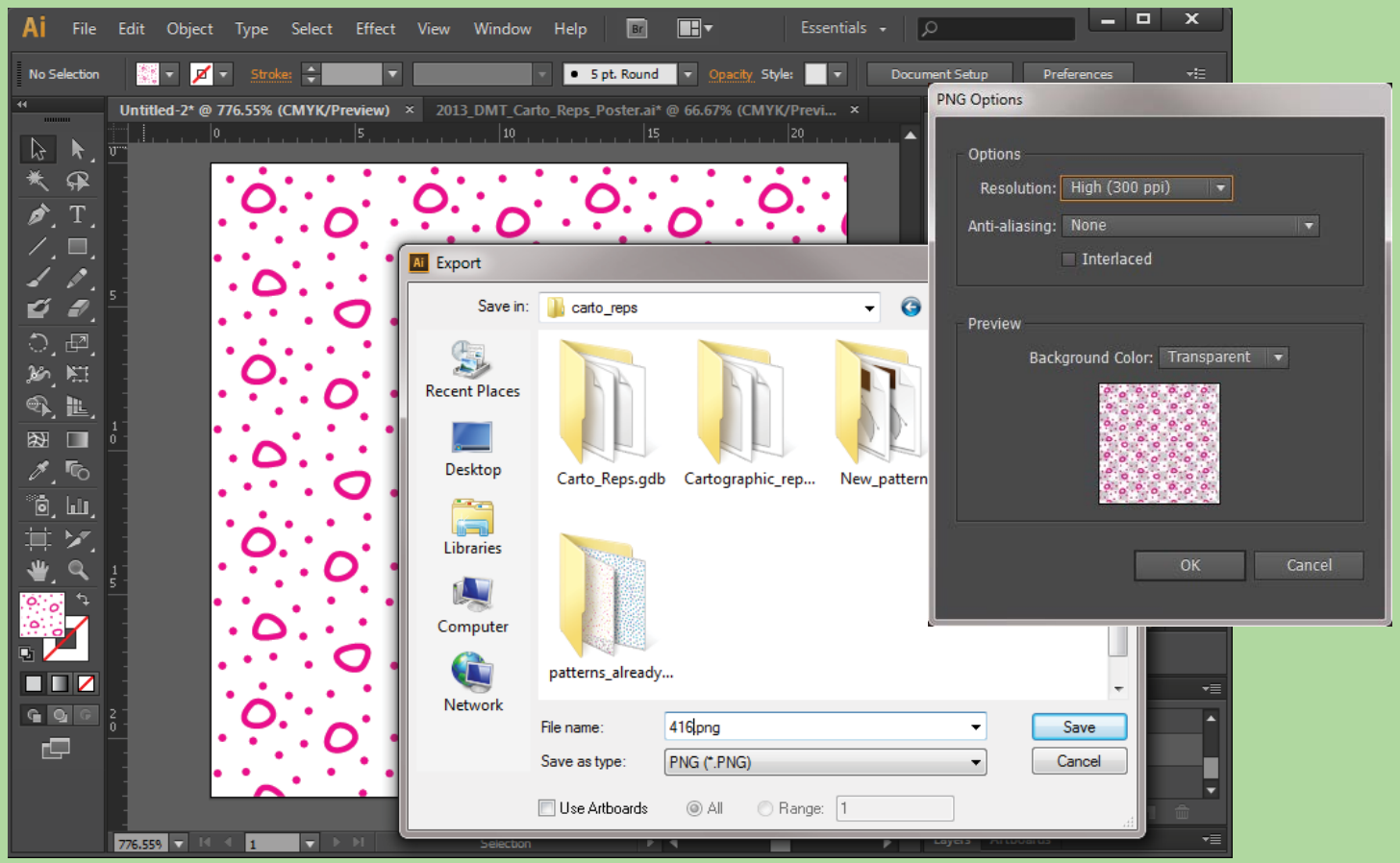
Pattern from Esri Geology 24K style file



Patterns as cartographic representations



Creating Pattern Fill Representations From Scratch



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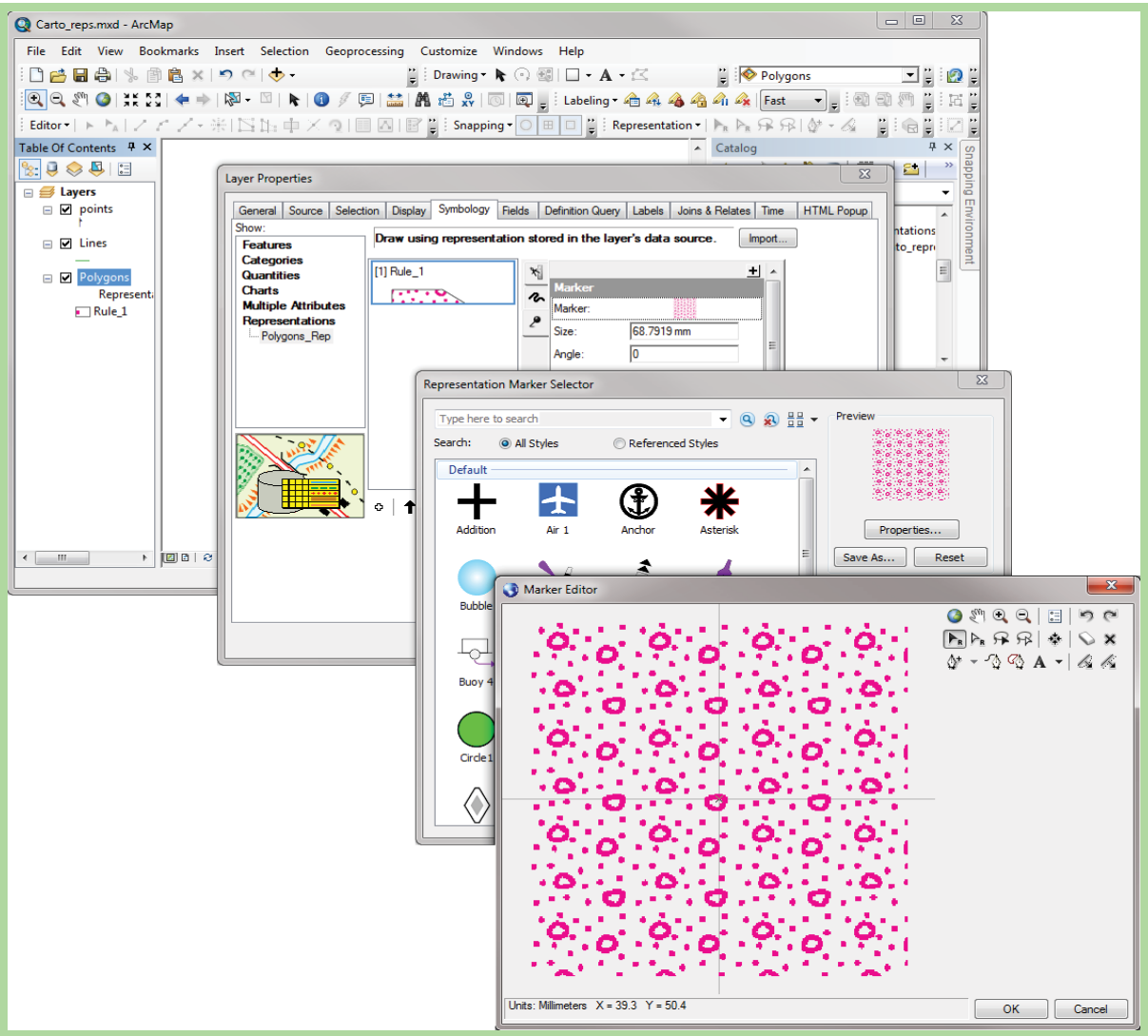
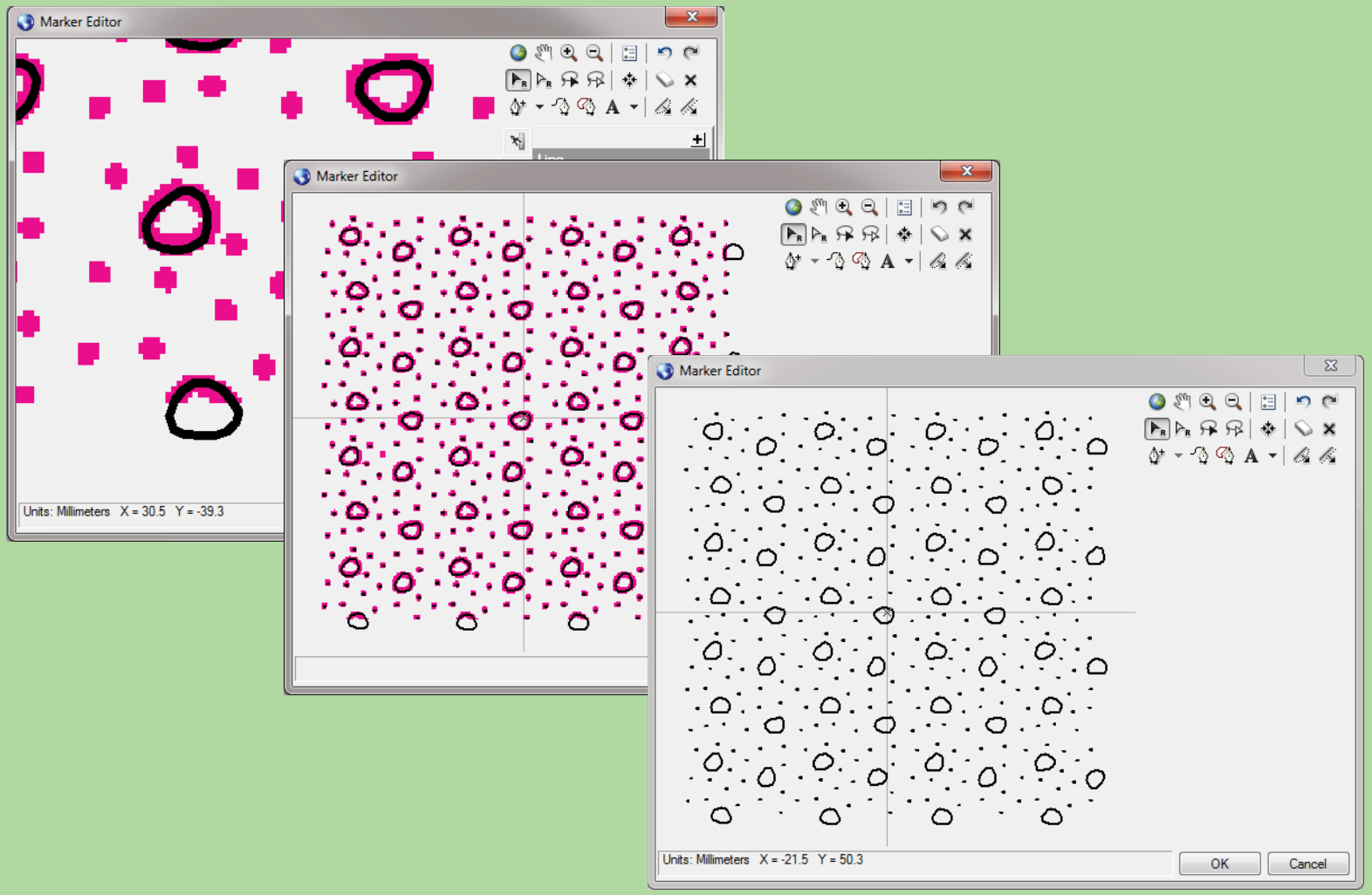
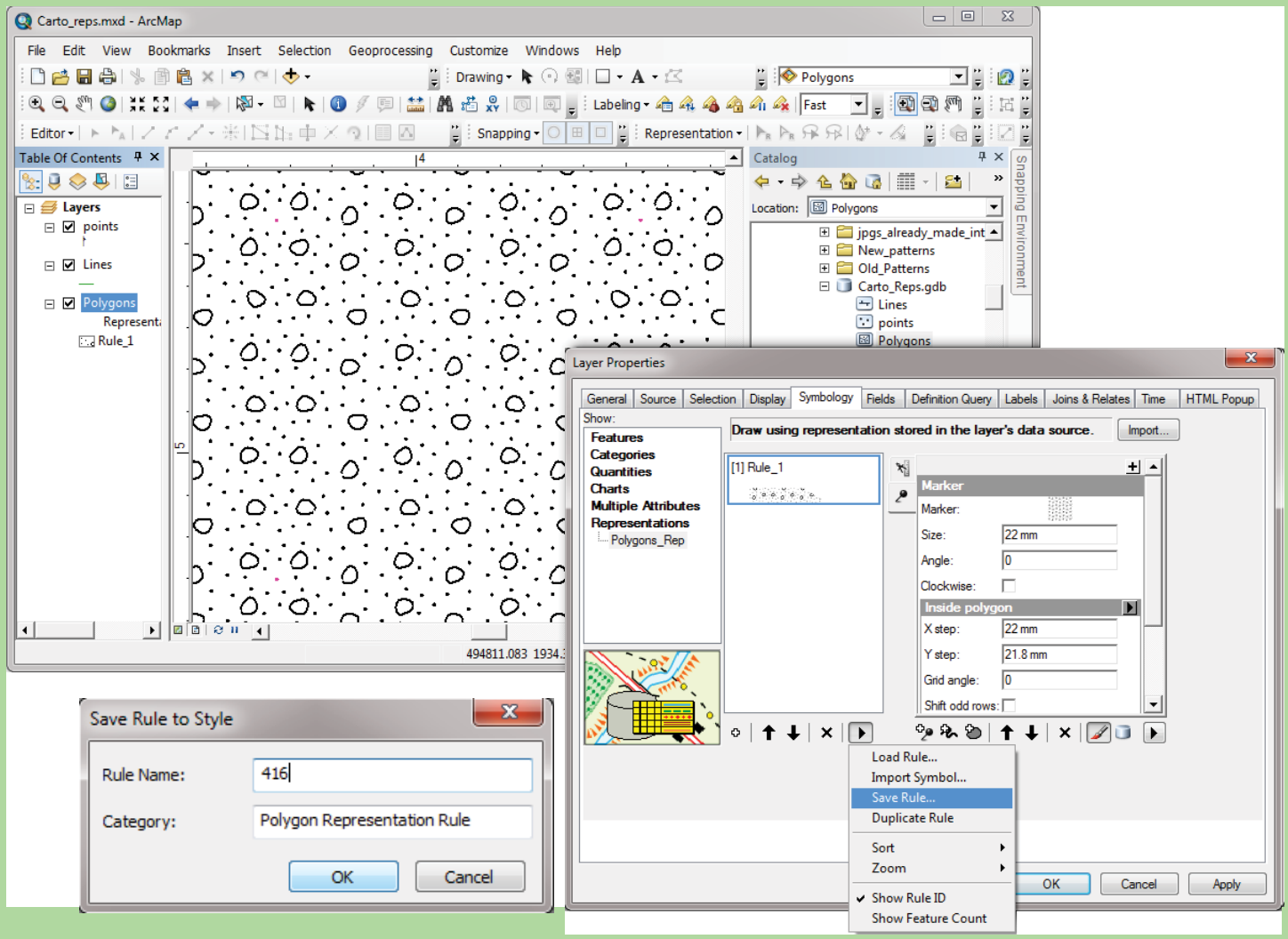
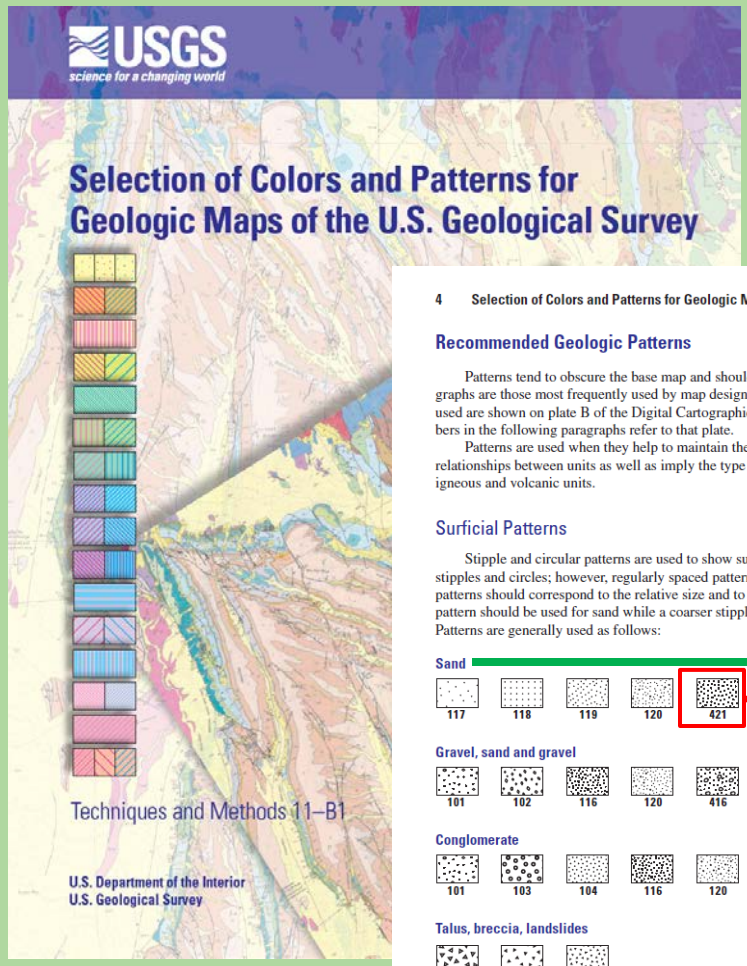


Creating Pattern Fill Representations From Scratch



Creating Pattern Fill Representations From Scratch





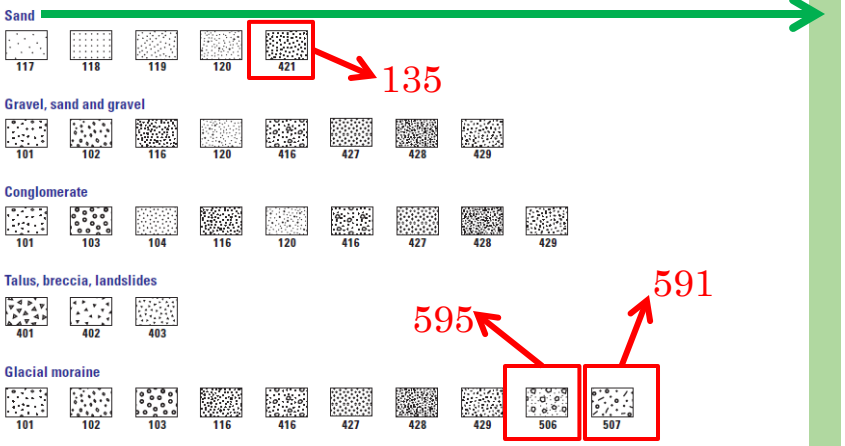
Recommended Geologic Patterns

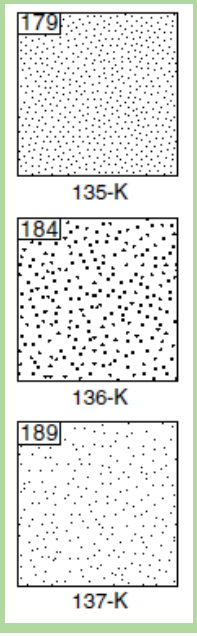
Patterns tend to obscure the base map and should be used only when necessary. The patterns shown in the following paragraphs are those most frequently used by map designers in the USGS. These patterns and many others that are less frequently used are shown on plate B of the Digital Cartographic Standard (see http://pubs.usgs.gov/of/1999/of99-430/). The pattern numbers in the following paragraphs refer to that plate.

Patterns are used when they help to maintain the basic color scheme on complex maps; they often can effectively show relationships between units as well as imply the type of rock being represented. Patterns are most often used for surficial and for igneous and volcanic units.

Surficial Patterns

Stipple and circular patterns are used to show surficial deposits. Normally these patterns have a random arrangement of stipples and circles; however, regularly spaced patterns may be used to create contrast among units. Generally, the spacing of the patterns should correspond to the relative size and to the character of the material being represented. For example, a fine stipple pattern should be used for sand while a coarser stipple pattern with or without circles indicates a coarse gravel or conglomerate. Patterns are generally used as follows:





QUESTIONS

This geocaching corgi can't wait to get home and turn his data into a map with a standardized format!

Thank you DMT organizers and participants!

CHANGING A LEOPARD'S SPOTS

Creating patterns as cartographic representations for geologic maps

By Patricia E. Gallagher, Alaska Division of Geological & Geophysical Surveys

What You Will Need

- ArcGIS for Desktop (Standard or Advanced license)
- Adobe Illustrator 8.0
- Adobe Illustrator swatch library containing FGDC patterns
- U.S. Geological Survey Techniques and Methods 11-B1 manual—Selection of colors and patterns for geologic maps of the U.S. Geological Survey
- Federal Geographic Data Committee Digital Cartographic Standard for Geologic Map Symbolization—Pattern chart
- A basic knowledge of ArcGIS for desktop
- A good understanding of how to create cartographic representations using the Marker Editor

Introduction

Geologic maps are often admired as not only 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. 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. When applied to a map, the Geology 24K picture fill patterns are pixelated. In contrast, patterns created using marker symbols within a representation rule are clear, crisp, and consistent at any scale. This exercise will detail how to create a pattern as a cartographic representation rule.

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. Pattern 416 can also be found in the Federal Geographic Data Committee (FGDC) Pattern Chart. 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).

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.

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 22mm wide and 22mm 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.

Transform the Template Tile into a Cartographic Representation Rule

When creating cartographic representations from scratch, it is useful to create a new geodatabase that contains a simple polygon feature class. Create one simple polygon in the feature class. Using only a single polygon helps improve draw time for complex patterns.

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.
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 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. 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.

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.
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 21mm. These step values are just a starting point and may need to be adjusted later.
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.

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. 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).
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.

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.

Summary and Acknowledgments

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 at patricia.gallagher@alaska.gov.

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 the staff of the Alaska Division of Geological & Geophysical Surveys (DGGS) for their support and encouragement in pursuing this project.

Resources and Helpful Links

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