

USA Potential

DIGITAL MAPPING TECHNIQUES 2015

The following was presented at DMT'15 (May 17-20, 2015 - Utah Geological Survey, Salt Lake City, UT)

The contents of this document are provisional

See Presentations and Proceedings from the DMT Meetings (1997-2015) http://ngmdb.usgs.gov/info/dmt/

Geologic Hazard Mapping ArcScan

AN IMAGE PROCESSING APPROACH



Ben Erickson, M.S., P.G. Hazard Mapping Geologist



geology.utah.gov

UTAH GEOLOGICAL SURVEY

Hazard Mapping

In 2008, a hazard mapping initiative was created through state legislative funding.

Four dedicated hazard mapping initiative geologists with the assistance of hazard mapping geologist in Southern Utah.

Maps are based on 7.5' quadrangle maps using geologic and other data.

http://geology.utah.gov/map-pub/maps/geologic-hazard-maps/

Quadrangle Hazard Maps

- Earthquake hazard
 - Surface fault rupture and liquefaction
- Landslide hazard
 - Landslides and rockfalls
- Flood hazard
 - Flooding by creeks, rivers, and other drainages; flash floods, sheetflow, and debris flows

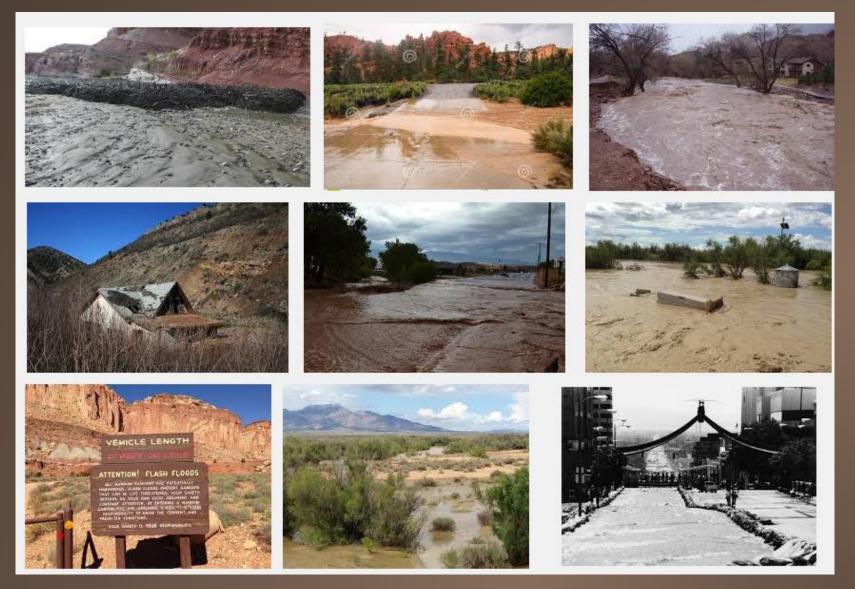
Problem soil and rock hazard

Expansive soil and rock, collapsible soil, shallow bedrock, soil piping and erosion, and windblown sand

Other hazards

Radon gas and shallow groundwater

Flood Hazard Focused Mapping



A Google image search for Utah Flooding. The search demonstrates a need for flood hazard mapping within the state.

Flood Hazard Focused Mapping



2002 Santaquin, UT Fire Related Debris Flow

Part of our mapping initiative is to explain the variety of flood types and raise awareness and identify their hazard.

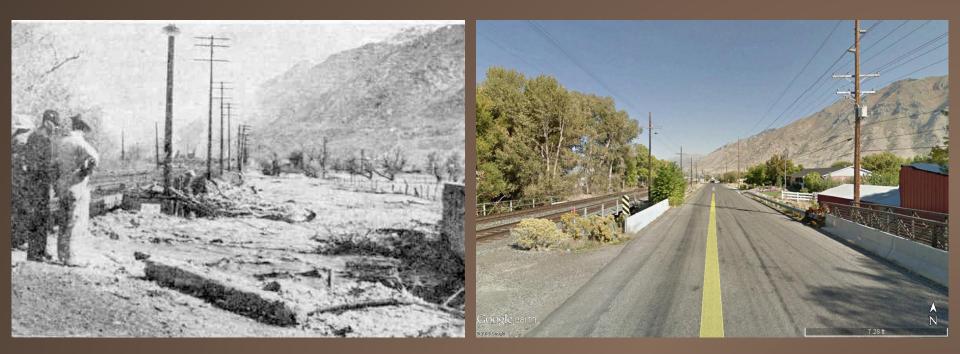
Springville, UT 1952 Flood





Floods are quickly forgotten over time; growing up in Springville I was unware of the extent of flood potential and past events. Further development in the city has encroached on the flood plains and many residents are unware of the hazard.

Springville, UT 1952 Flood



1952 Flooding

2013 Google Street View

A time comparison between 1952 and 2013. Much of the flooded land now has residential development and would be highly susceptible to flooding.

Flood Hazard Focused Mapping

- Utah's need for detailed flood hazard mapping, beyond FEMA FIRM maps.
- U.S. Army Corps of Engineers (USACE) wanting to assist states with projects.
- Contracting with USACE in 2013.
 - In-kind cost share funding
 - 44 quadrangles
 - Digitize geologic and FEMA FIRM maps
 - Develop web platform for finished maps
 - 2 ½ year project

Flood Hazard Mapping Technique Based on the geologic conditions of various mapped units, such as depositional environments and age. DEM, available LiDAR, aerial photos. Supplement other flood-hazard maps already used in land-use planning and regulation (FEMA Flood maps). Show flooding hazards not on FIRM maps, such as debris flows.

Project Challenges

USACE

- Misinterpreted scope
 - Over focus on FEMA FIRM digitization
 - Lack of funding for geologic map digitization
 - Much lower prioritization of web platform map
- Change in their manager
- Quadrangle substitutions
- We start digitizing geologic maps, as needed
 - 5 maps USACE completed
 - 14 maps need digitizing

Digitizing Maps

- Different methods
- Primarily, manual line tracing
- Hours of line tracing
- Precision to line tracing is paramount for high quality duplicate maps
- More hours of line tracing
- Ensure edits are saved
- Hours of line tracing
- Finished line tracing

ESRI ArcScan

xtensions 📃 🔀
Select the extensions you want to use.
✓ 3D Analyst ✓ ArcScan ✓ Geostatistical Analyst ✓ Network Analyst ✓ Publisher Schematics Spatial Analyst ✓ Task Assistant Manager ✓ Tracking Analyst ✓ Workflow Manager
Description:
ArcScan 10.3 Copyright ©1999-2014 Esri Inc. All Rights Reserved Provides support for the creation of vector features from a raster image.
Close

What is it?

- An ArcMap extension
- Why is it used?
 - Automates features detection
 - Makes your digitizing life easier
- How does it work?
 - Identifies difference between two colors
 - Pixel recognition
 - Creates a line or polygon based on pixel width

ArcScan Settings

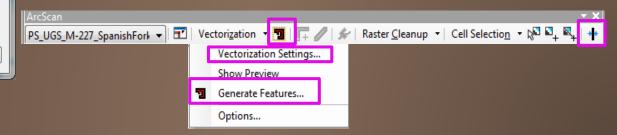
Editing Options							
General Topology Versioning	g Units Annotation Attributes						
Display measurements using	3 decimal places						
Sticky move tolerance:	0 pixels						
Stretch geometry proportionately when moving a vertex							
Use symbolized feature du	ring editing						
Use classic snapping							
Show feature construction	toolbar						
Show warnings and inform	ation on start editing						

Vectorization Settings	I h l.	×
Intersection Solution:	Geometrical 🔹	
Maximum Line Width:	20	1 - 100
<u>N</u> oise Level:	65	0% - 100%
Compression Tolerance:	0.025	0.001 - 50
Smoothing Weight:	3	1 - 20
Gap Closure Tolerance:	10	1 - 1000
<u>F</u> an Angle:	60	0 - 180
Hole Size:	0	0 - 100
Resolve Corners		
Maximum <u>A</u> ngle:	135	0 - 180
Styles Load or save	a pre-defined vectorizatior	n style
About vectorization	Apply	Close

Editing Options Uses Classic Snapping ArcScan Tool Bar Active when editing features Select layer for vector scanning Determine pixel width "Raster Line" Width" tool for vector settings 🕂 "Generate Features Inside Area" will

generate within a drawn polygon **1**

 "Generate Features..." will open options for full layer generation



Generate Features...

Generate Features						
Choose the line layer to add the centerlines to:						
TemplateLinesScanned_Band1						
Save the average width of each line feature to an existing field:						
· · · · · · · · · · · · · · · · · · ·						
☑ Generate polygons where the maximum line width setting is exceeded						
Choose the polygon layer to add these polygons to:						
Template PolygonsScanned_Band1						
Generate features for the currently selected cells only						
Select the new features						
Tip: This dialog generates features from the full extent of the raster. To generate features for a specific extent, use the Generate Features Inside Area tool.						
OK Cancel						

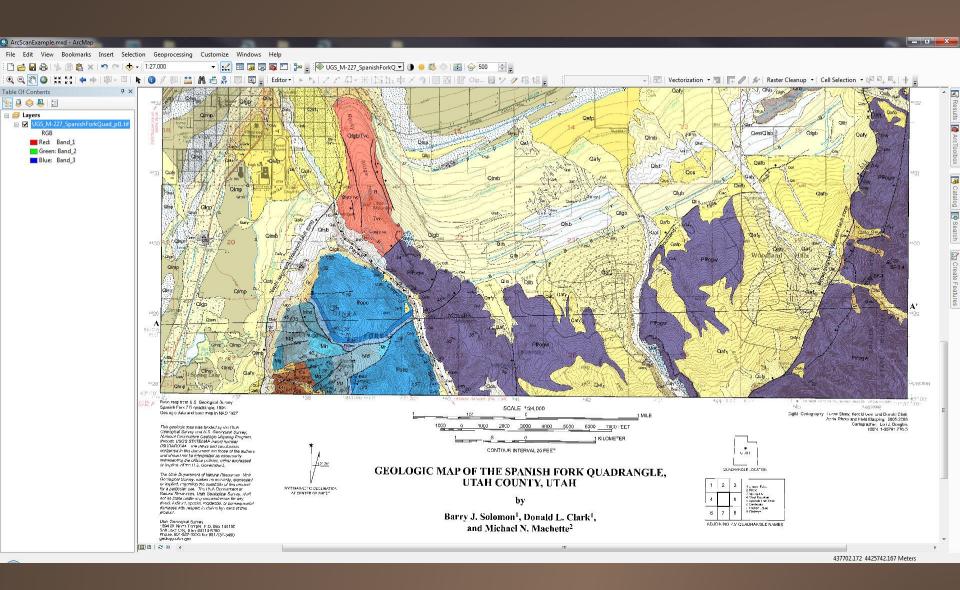
ArcScan						▼ X
PS_UGS_M-227_SpanishFork 🔻 🛨	Ve	ctori <u>z</u> ation 👻 <u>।</u> 류	1 4	Raster <u>C</u> leanup	▼ Cell Selection	- 🔊 🗳 🗛 🗰
		Vectorization Settings				
		Show Preview				
	ъ	Generate Features				
		Options				

Generate Features Options

- Must have layers turned on
- Enable/disable polygon generation
- Option to select new features when generated
- Generation will take a few seconds to minutes

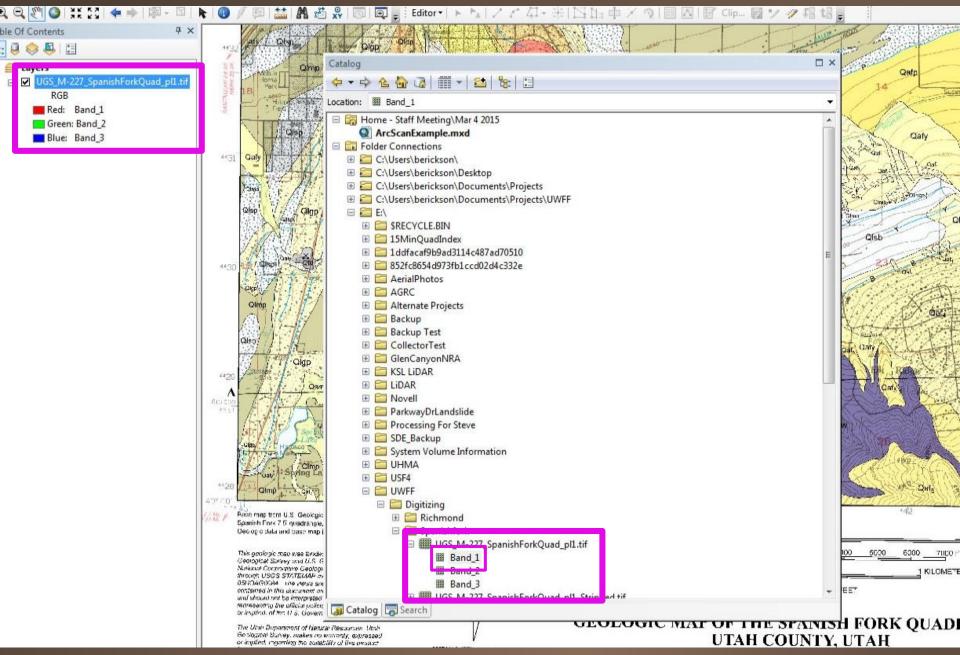
First Attempt

Load a georeferenced map

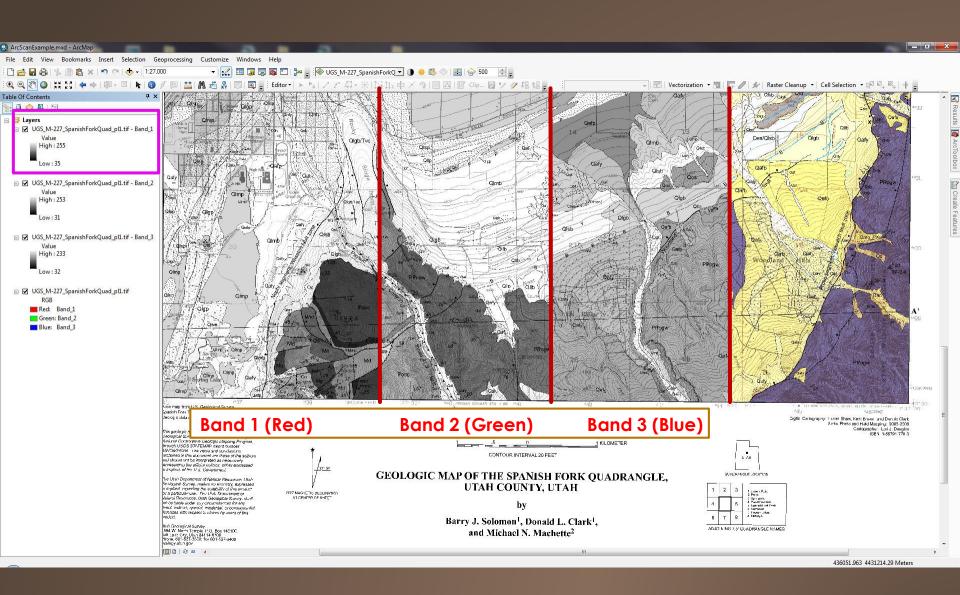


First Attempt

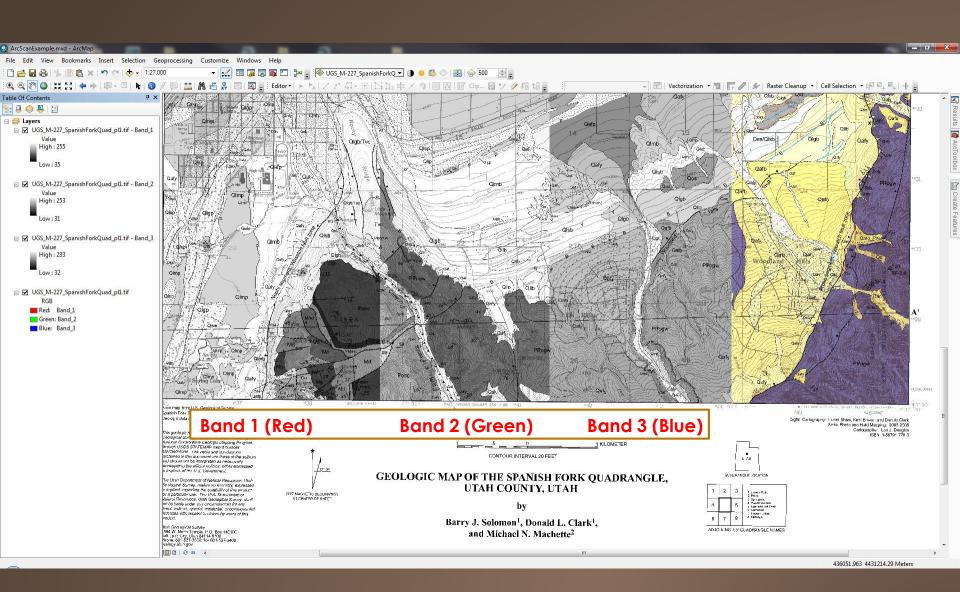
Load a georeferenced map
 Load individual bands of the color raster



An example of how to load a single color band for a image file using ArcCatalog for ArcScan processing.



A comparison of the RGB colors of the image file and how different colors change the grayscale representation.



Removal of RGB color boundary lines for better comparison.

First Attempt

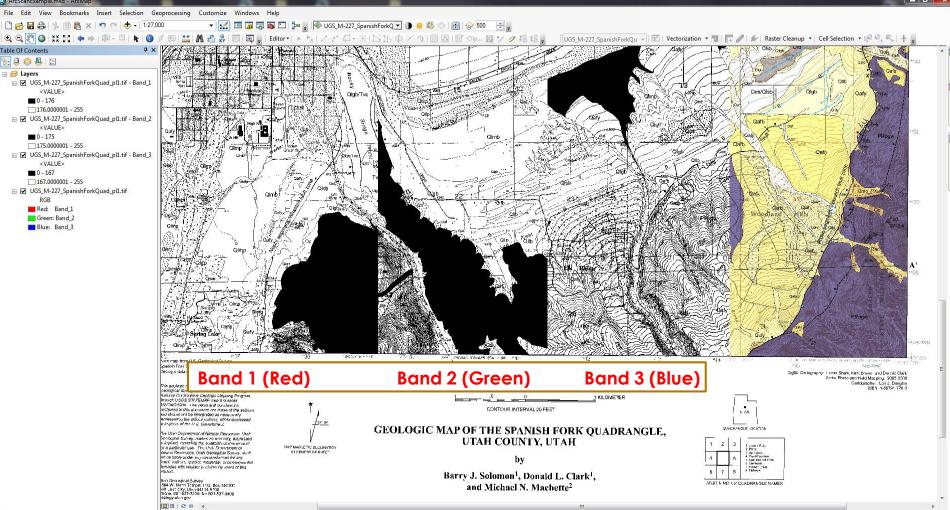
Load a georeferenced map
Load individual bands of the color raster
Set the Symbology to Classified using 2 Classes (Unique Values is also acceptable)

eneral Source Exte	ent Display	Symbology	Time					
ow: ector Field nique Values	Draw ra	ster groupi	ng values into	classes				
lassified tretched iscrete Color	Fields Value	<value:< td=""><td colspan="3"><value></value></td><td colspan="3"><none> •</none></td></value:<>	<value></value>			<none> •</none>		
	Classific		aks (Jenks)	Classes 2	•	Classify		
	Color Ram	Color Ramp						
	Symbol	Range		Label				
		0 - 176]176 - 255		0 - 176 176,0000001 - :	255			
About symbology		class breaks Ishade effec	using cell values t Z:	1	Display NoDa	ta as 🗾 🕨		
DOUT SYMDOLOGY								

Set the Symbology to Classified using 2 Classes, defining black from white. Unique Values can also be used for color classification.

ArcScanExample.mxd - ArcMap

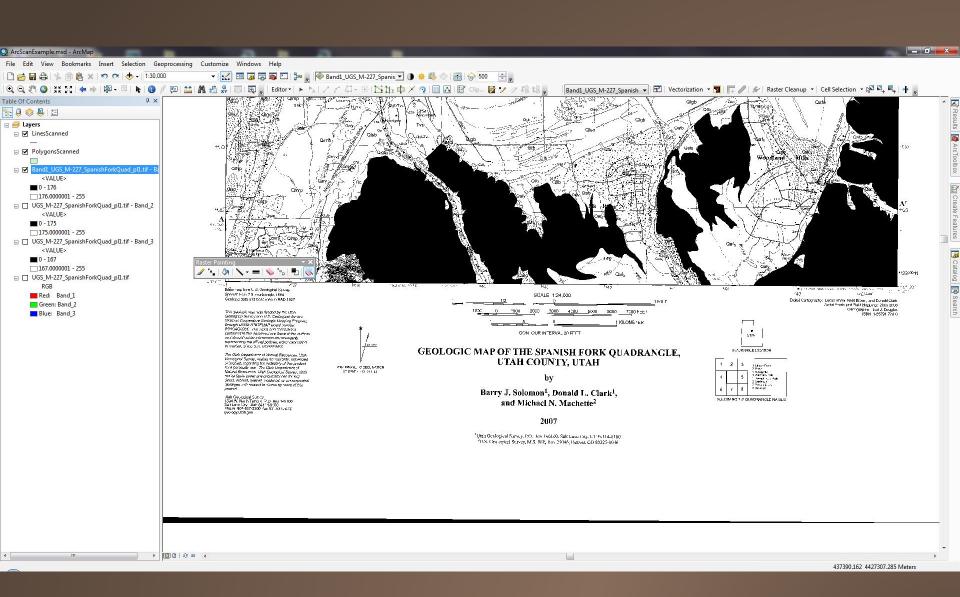
436144.831 4431042.84 Meters



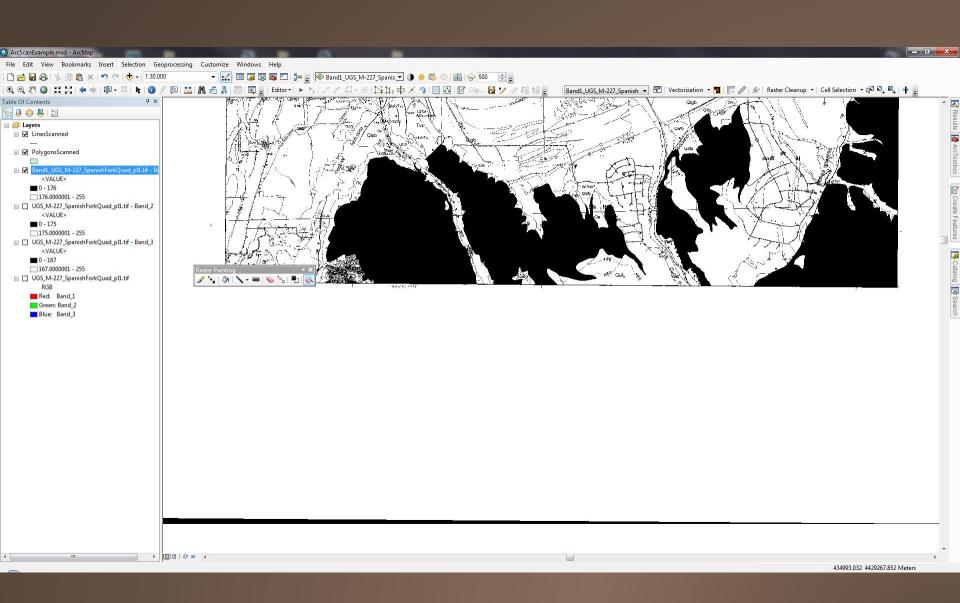
Results of black and white classification of the RGB values.

First Attempt

- Load a georeferenced map
- Load individual bands of the color raster
- Set the Symbology to Classified using 2 Classes (Unique Values is also acceptable)
- Turn on ArcScan toolbar, start an editing session for lines and polygon features, use Raster Painting toolbar to cleanup the raster



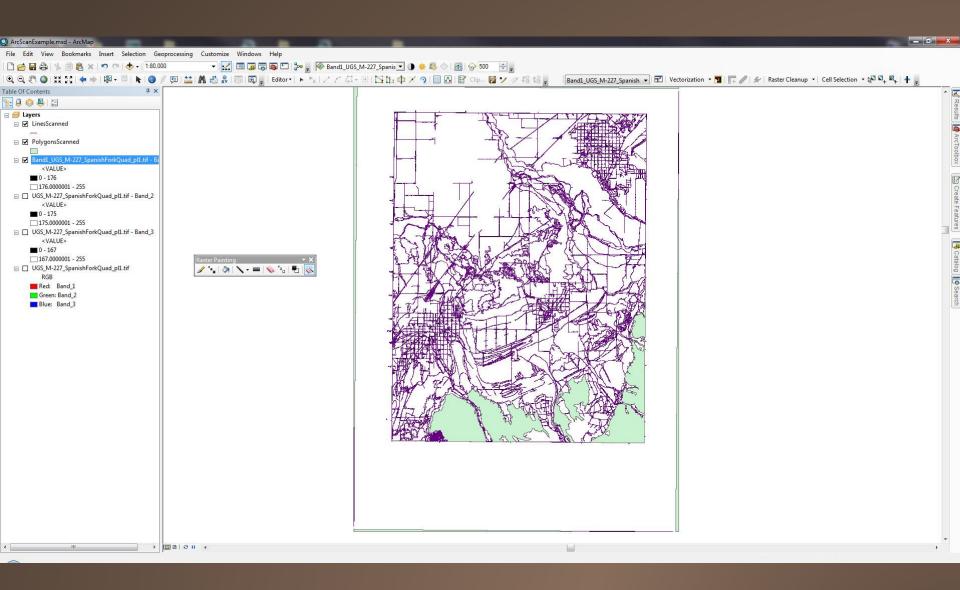
Red band selected for ArcScan processing. Turn on ArcScan toolbar, start an editing session for lines and polygon features.



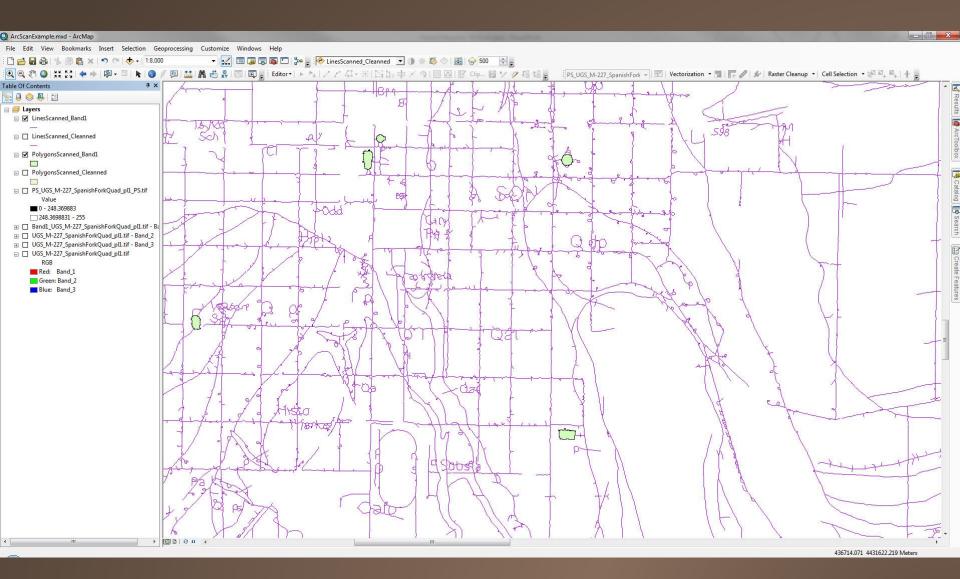
Enable Raster Painting toolbar to cleanup the raster.

First Attempt

- Load a georeferenced map
- Load individual bands of the color raster
- Set the Symbology to Classified using 2 Classes (Unique Values is also acceptable)
- Turn on ArcScan toolbar, start an editing session, and clean up the image
- Run scan automation



Results from the First Attempt of running ArcScan.

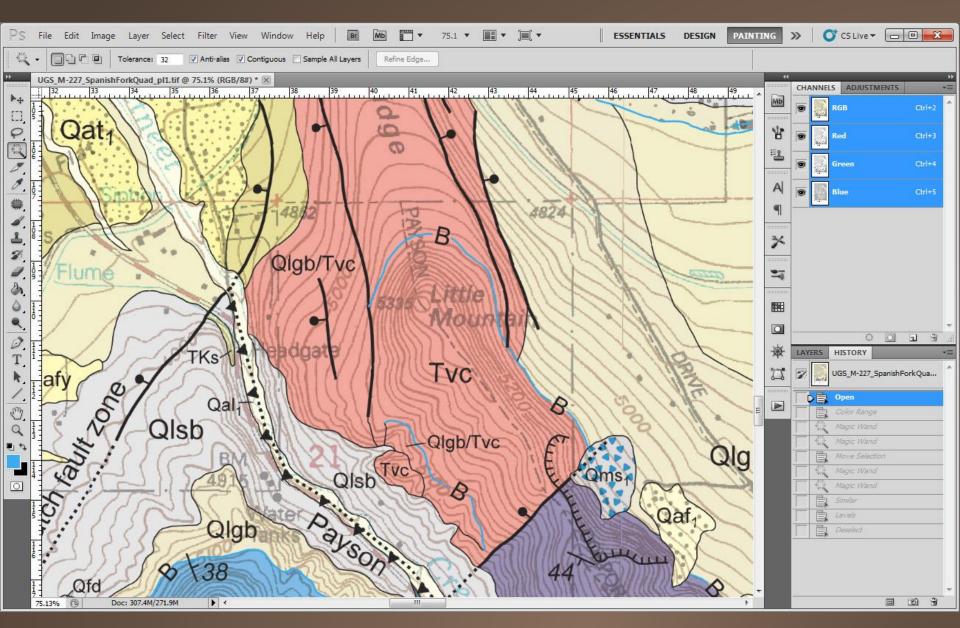


A zoomed in view of the roads and contact lines of the first ArcScan attempt.

Current Workflow

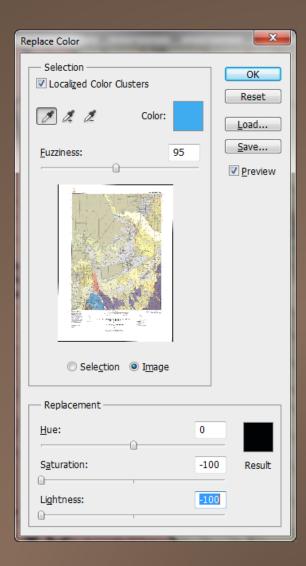
Use an image processor (Photoshop or GIMP) to convert the TIFFs to two colors

Change non-black boundary lines to black

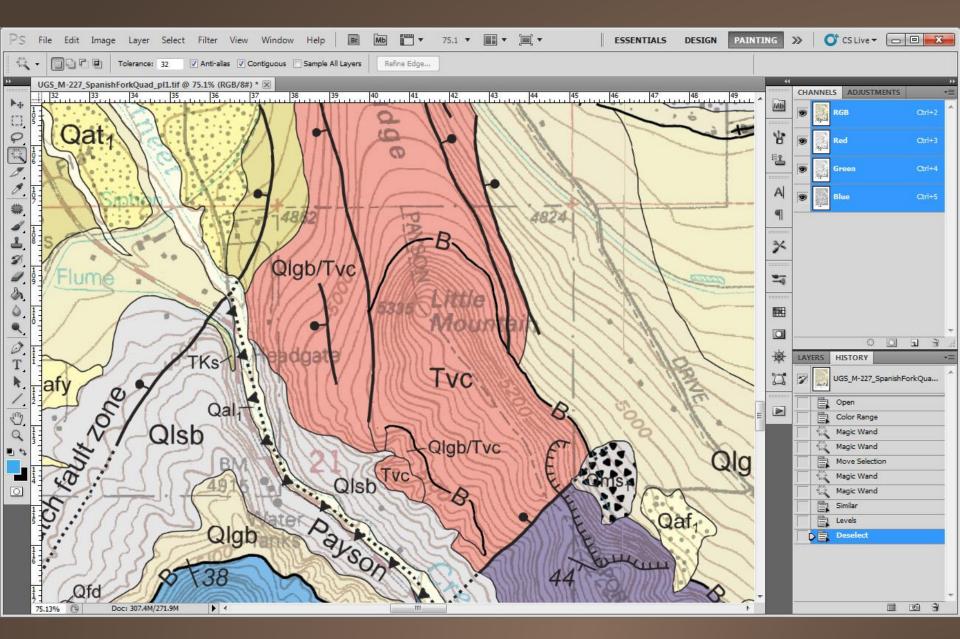


Load georeferenced image into an image processor.

Ps	File Edit	Image Layer Select Filter View Window Help Br Mb	. • 1
٩	- @Q	Mode	Fit Screen
	UGS_M-227_	Adjustments Brightness/Contrast Auto Tone Shift+Ctrl+L Auto Contrast Alt+Shift+Ctrl+L Auto Color Shift+Ctrl+B Image Size Alt+Ctrl+I Canvas Size Alt+Ctrl+C Image Rotation Black & White	Ctrl+L Ctrl+M Ctrl+U Ctrl+B t+Ctrl+B
		Crop Trim Reveal All Photo Filter Channel Mixer	
		Duplicate Invert Apply Image Posterize Calculations Gradient Map	Ctrl+I
ð.		Variables Apply Data Set	
ě		Trap Shadows/Highlights HDR Toning Variations	
Ø T		Match Color	t+Ctrl+U
× /		Replace Color Equalize	



Change colors that need to be recognized to black.



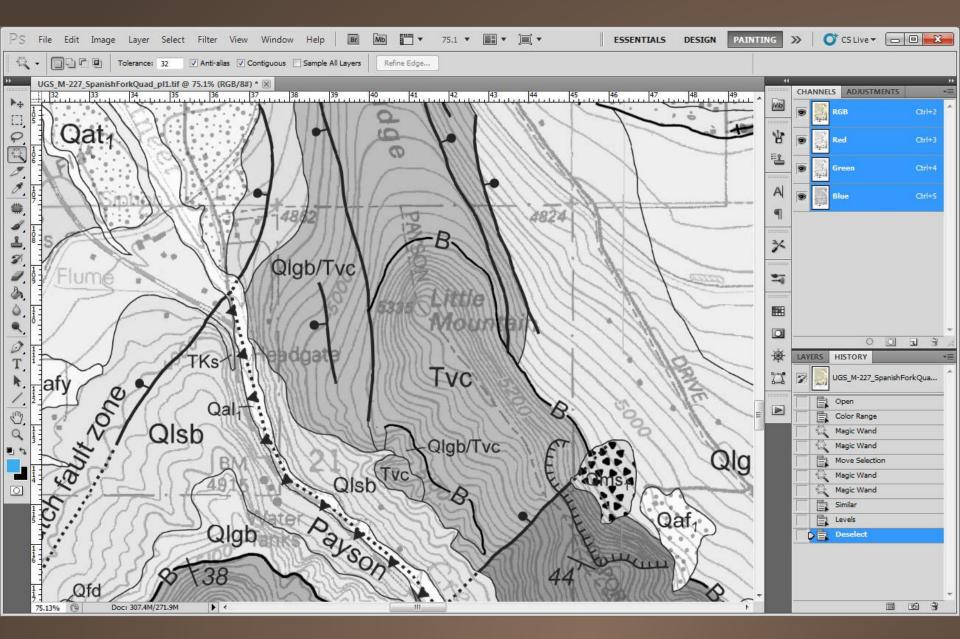
Result of the color change.

Current Workflow

Use an image processor (Photoshop or GIMP) to convert the TIFFs to two colors

Change non-black boundary lines to black

Change colors to grayscale

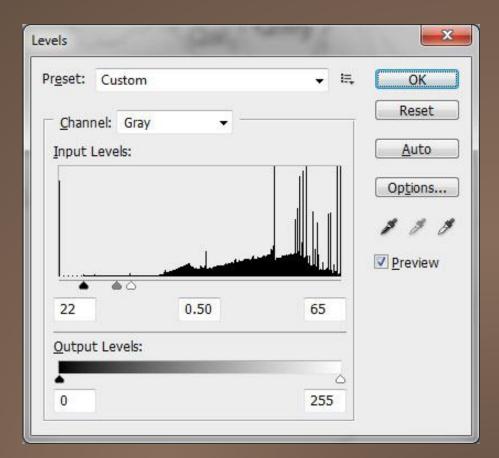


Change colors to grayscale in Image \rightarrow Mode \rightarrow Grayscale

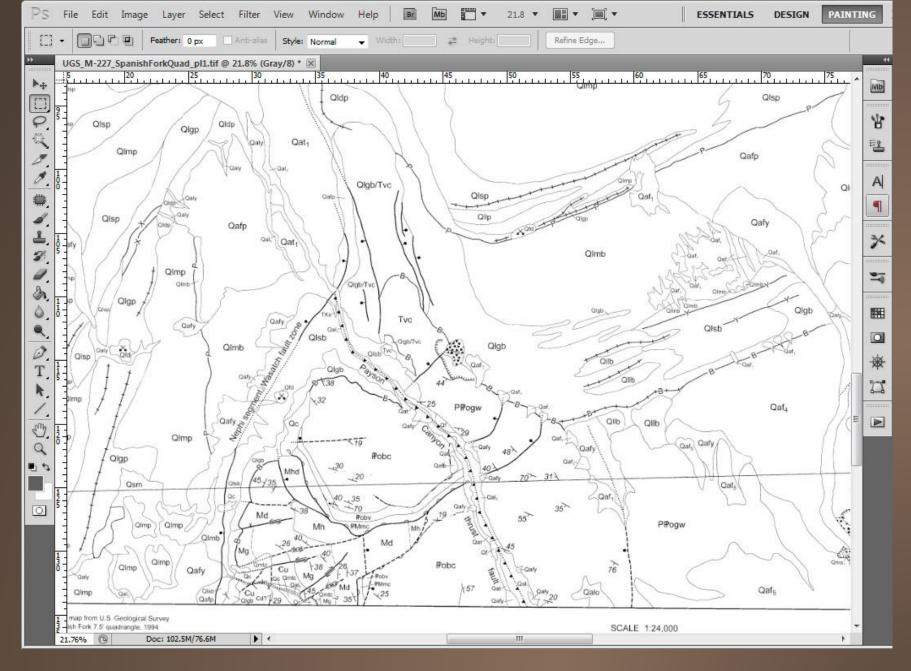
Current Workflow

- Use an image processor (Photoshop or GIMP) to convert the TIFFs to two colors
 - Change non-black boundary lines to black
 - Change colors to grayscale
 - Adjust levels of lines to black and everything else to white

Image Layer Select Filter View Mode	Window Help Br Mb T v 1
Adjustments •	Normal 👻 Width: 📰 Height: Brightness/Contrast
Auto Tone Shift+Ctrl+L Auto Contrast Alt+Shift+Ctrl+L Auto Color Shift+Ctrl+B	Levels Ctrl+L Curves Ctrl+M Exposure
Image Size Alt+Ctrl+I Canvas Size Alt+Ctrl+C Image Rotation Crop Trim Reveal All	Vibrance Hue/Saturation Ctrl+U Color Balance Ctrl+B Black & White Alt+Shift+Ctrl+B Photo Filter Channel Mixer
Duplicate Apply Image Calculations	Invert Ctrl+I Posterize Threshold Gradient Map
Variables Apply Data Set Trap	Selective Color Shadows/Highlights HDR Toning Variations
	Desaturate Shift+Ctrl+U Match Color Replace Color Equalize



Adjust image levels of lines to identify black compared to the rest of the image.

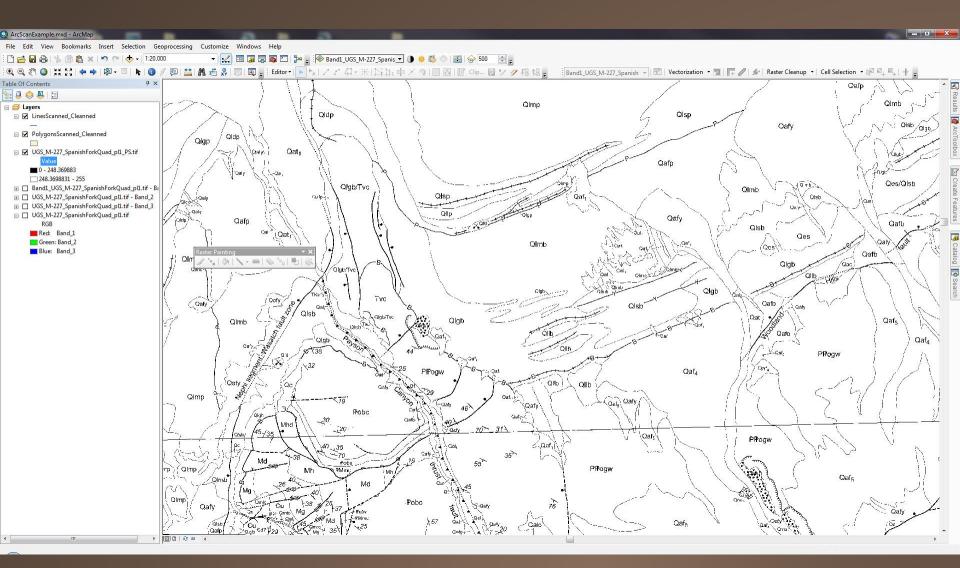


Results of level adjustments showing only geologic lines and labels.

Current Workflow

- Use an image processor to convert the TIFFs to two colors
 - Change non-black boundary lines to black
 - Change colors to grayscale
 - Adjust levels of lines to black and everything else to white

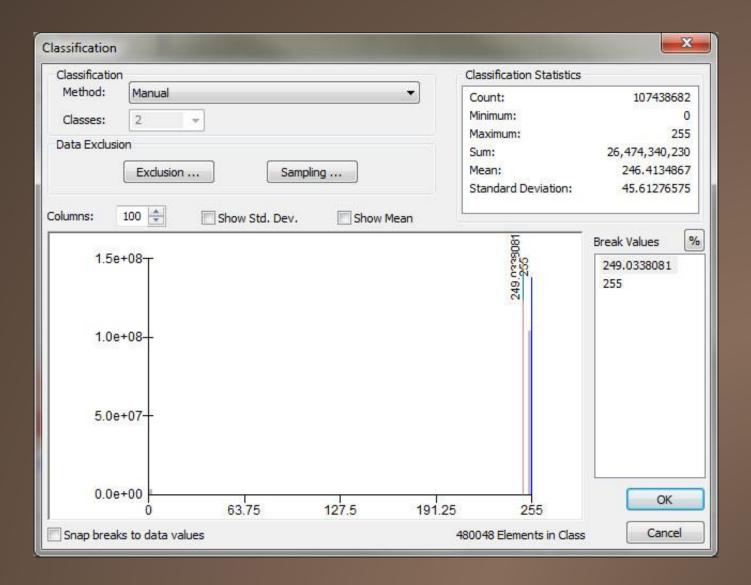
Load grayscale TIFF in ArcMap (copy the .tfw file from the original accompanying TIFF and rename it to match the name of the grayscale file). Follow the same steps to classify, clean, and automate scans



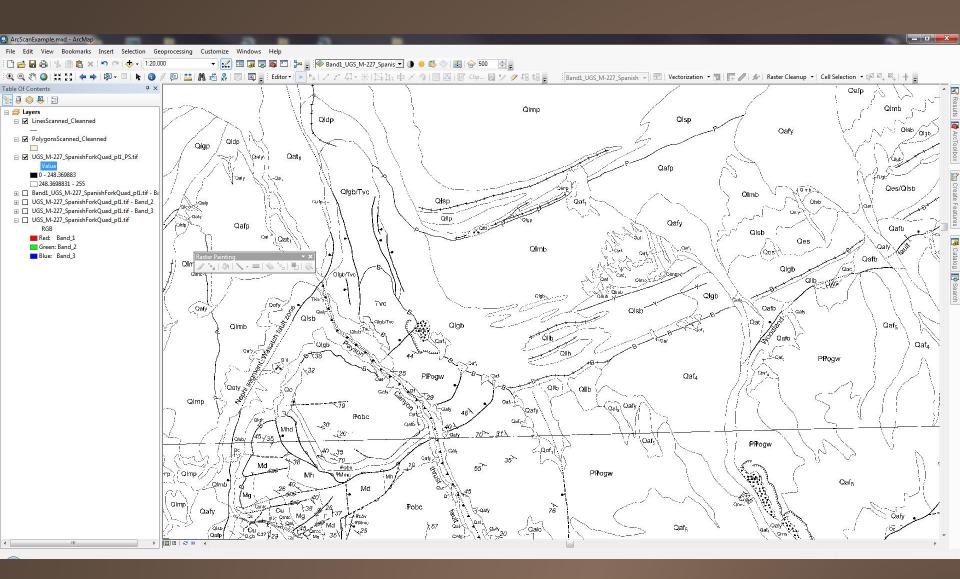
Load the adjusted image file into ArcMap, ensure the original accompanying world file is copied and renamed.

General Source Ex	tent Display	Symbology	Time				
how: /ector Field	Draw ras	ster group	ng values into	classes			
Unique Values							
Classified	Fields						
Stretched Discrete Color	Value	<value< td=""><td>> *</td><td>Normalization</td><td><none< td=""><td>> *</td><td></td></none<></td></value<>	> *	Normalization	<none< td=""><td>> *</td><td></td></none<>	> *	
	Classific		aks (Jenks)	Classes 2	•	Classify	
	Color Ram	P				•	
	Symbol	Range	Proc.	Label			
		0 - 176]176 - 255		0 - 176 176.0000001 - 2	255		
12							
bout symbology	al and a second second	dass breaks Ishade effec	using cell values t z	1	Display NoE	Data as	
				-	ок Г	Cancel	pply

Change the image symbology to classified with 2 classes



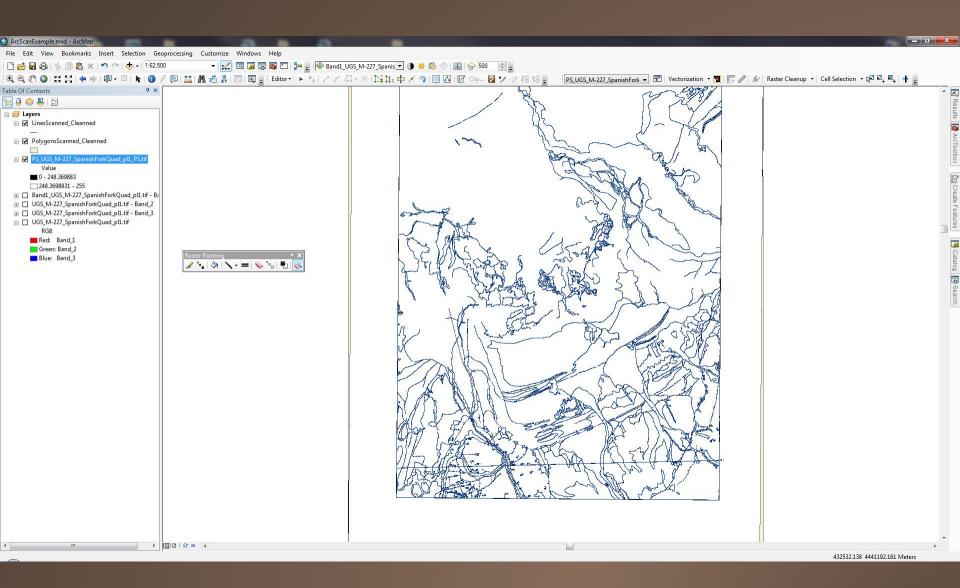
You can adjust the classes to identify white from black. The large number should represent the color white.



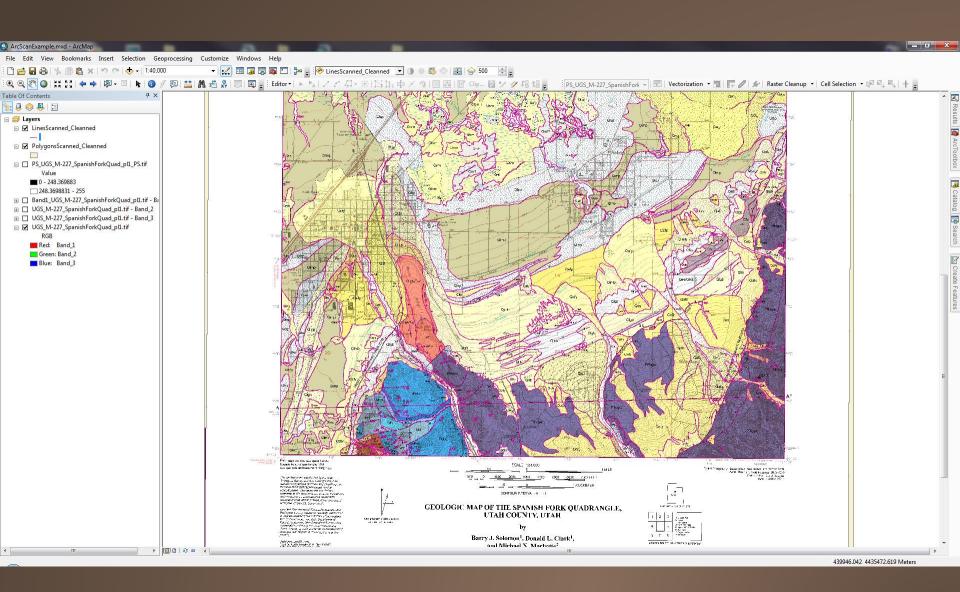
The resulting map after symbology change.

Current Workflow

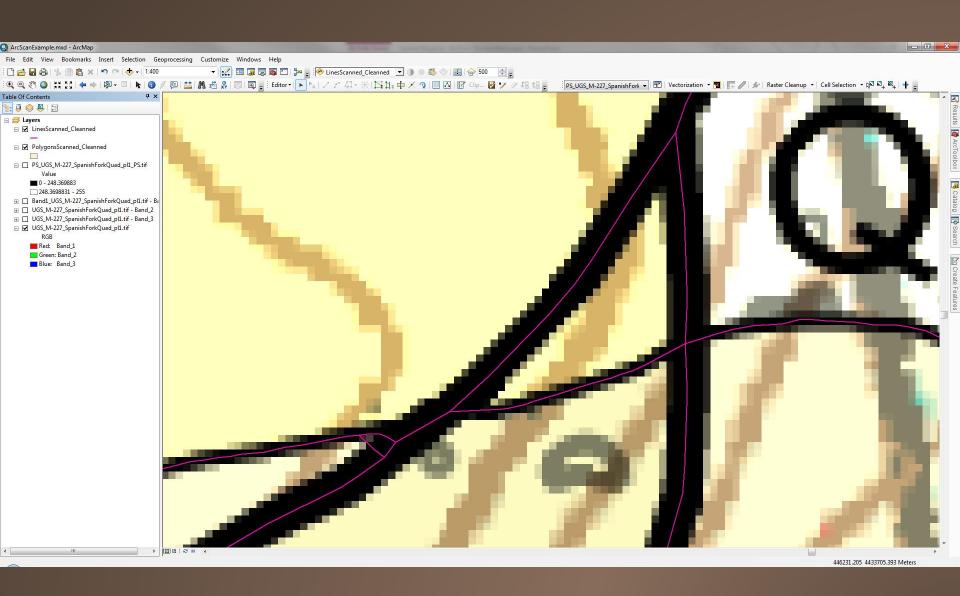
- Use an image processor to convert the TIFFs to two colors
 - Change non-black boundary lines to black
 - Change colors to grayscale
 - Adjust levels of lines to black and everything else to white
- Load grayscale TIFF in ArcMap (copy the .tfw file from the original accompanying TIFF and rename it to match the name of the grayscale file). Follow the same steps to classify, clean, and automate scans.
- Review the resulting features



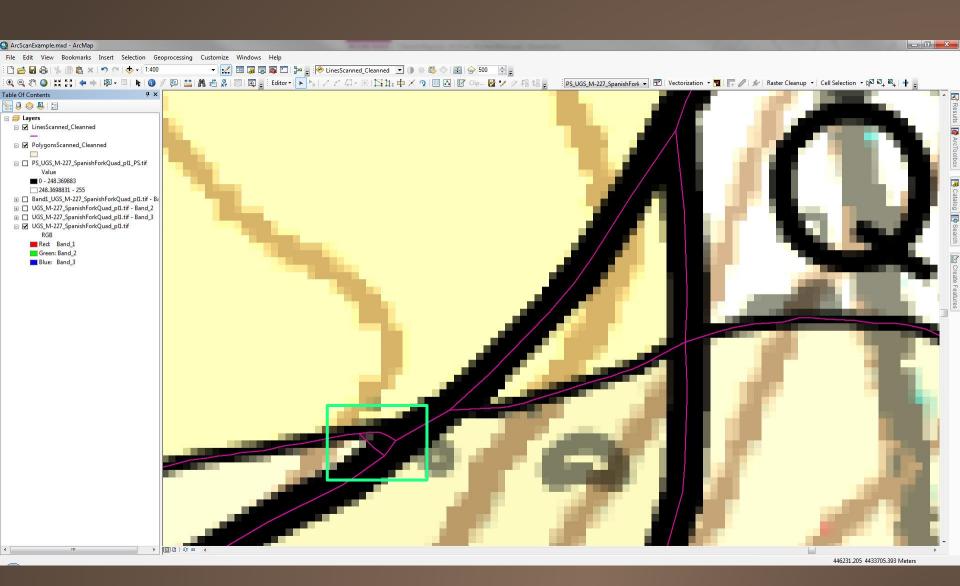
The resulting features after ArcScan processing.



The features after ArcScan processing overlaid on the image.

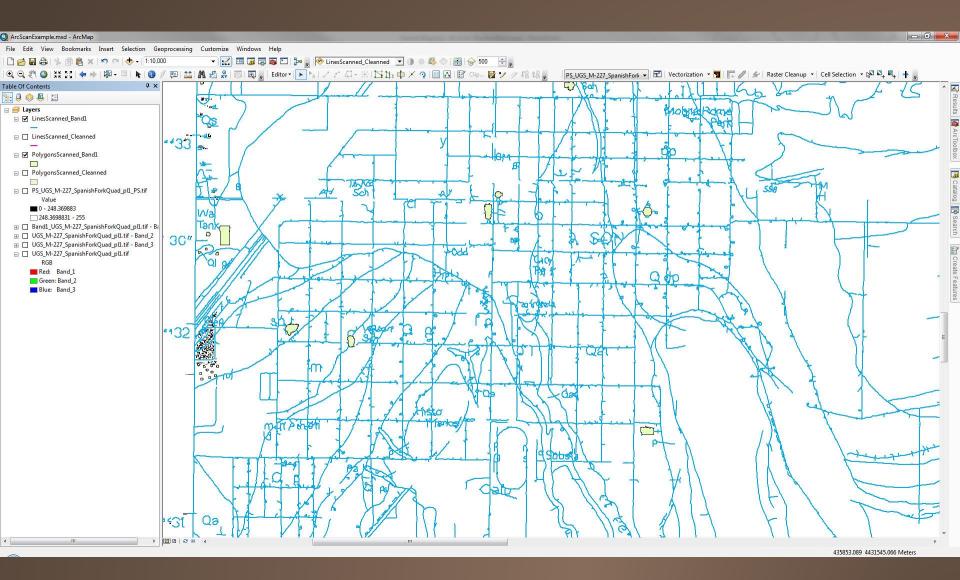


Zoomed features after ArcScan processing overlaid on the image.

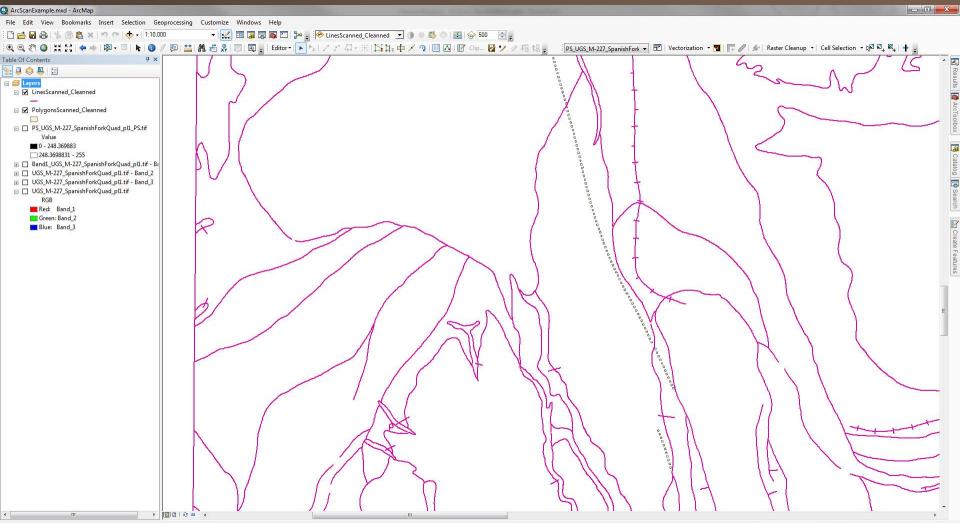


The feature shows potential extra lines after processing.

First Attempt Lines

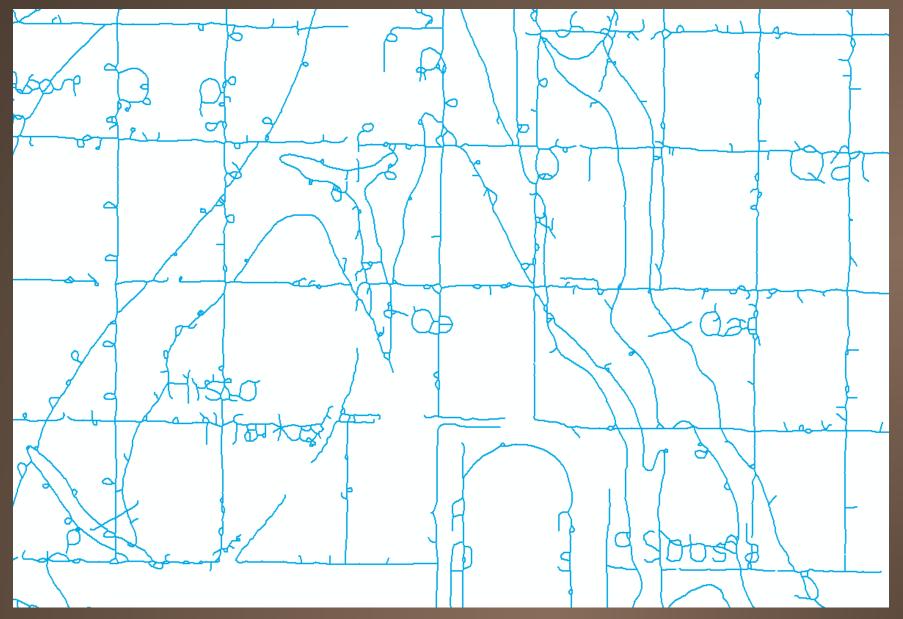


Current Workflow Lines

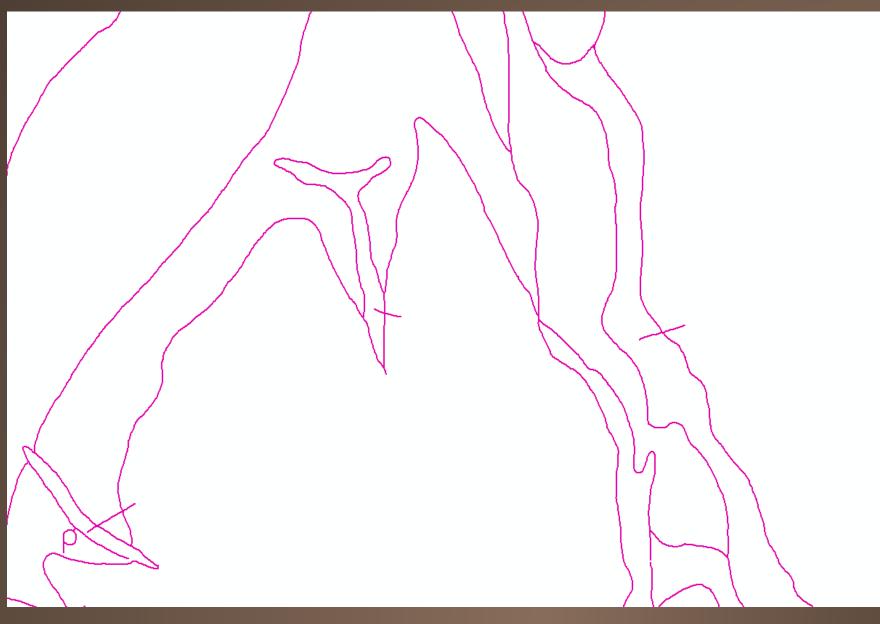


437797.78 4432232.984 Meters

First Attempt Lines



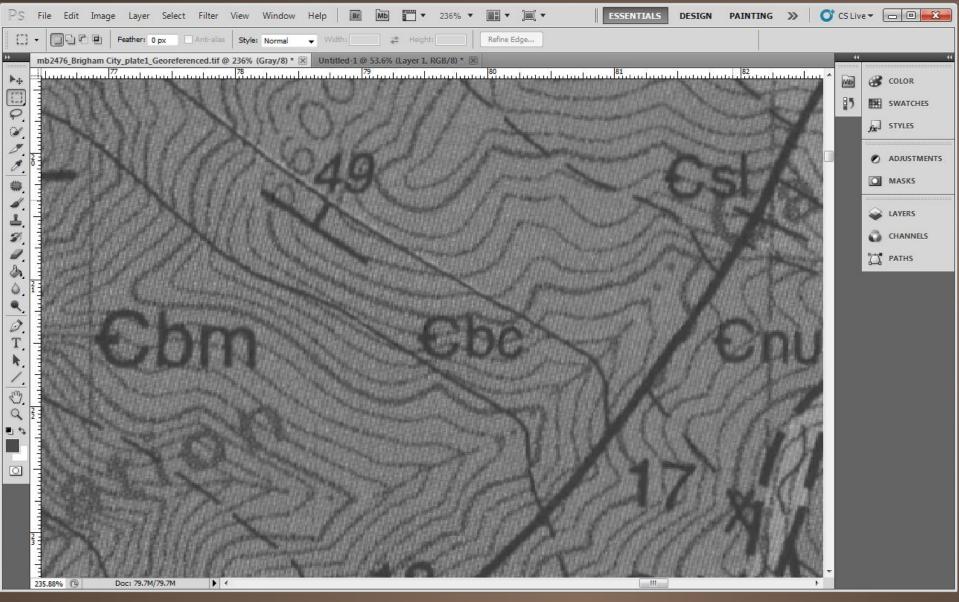
Current Workflow Lines



Challenging Map

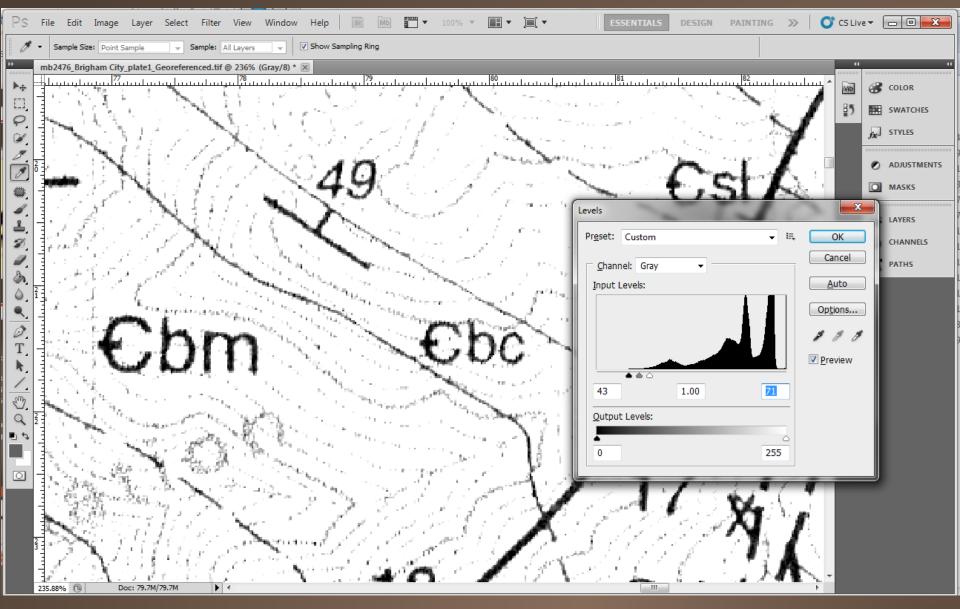
Challenging maps consist of faded, bleeding colors, and blurry lines making it difficult to identify lines to scan.

Challenging Map Grayscale



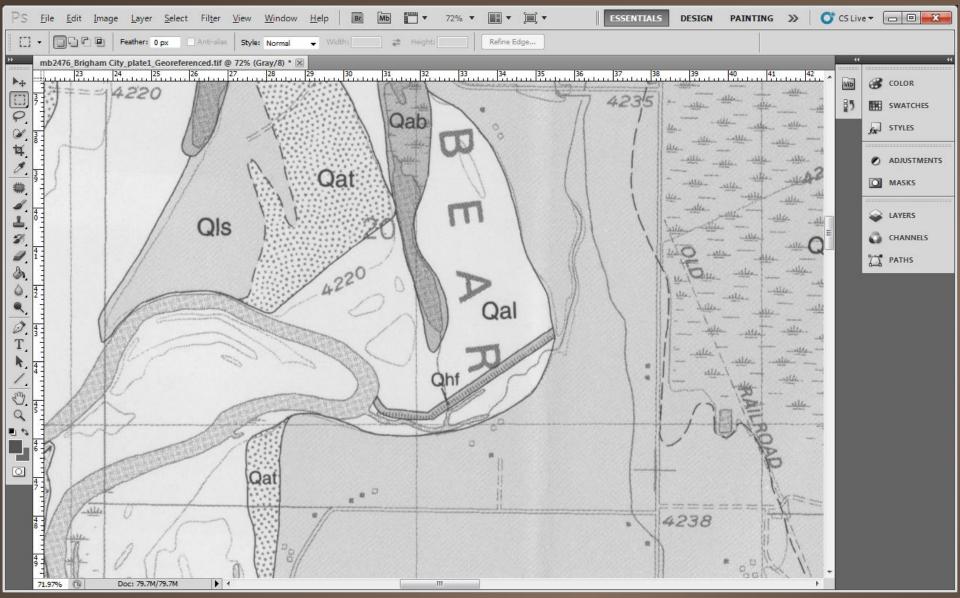
However the same process can get to a point of processing.

Challenging Map Levels



As seen, the level adjustment removes much of the gray but does not eliminate the contour lines.

Challenging Map Light Grayscale



Another part of the map show potential good lines.

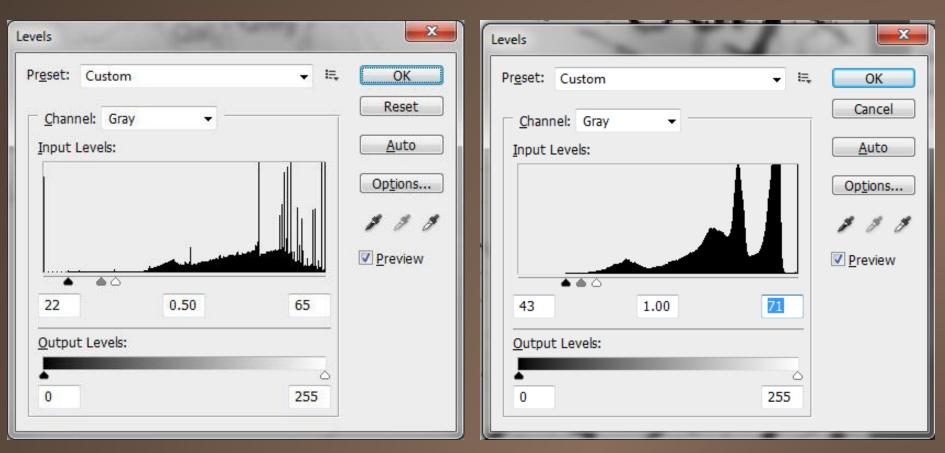
Challenging Map Light Levels

Ps	File Edit Image Layer Select Filter View Window Help 📴 📠 🎬 🛪 100% 🔻 📰 🔻 🗐 🕶 🛛 ESSENTIALS DESIGN PAINTING » 🚺	CS Live 👻 🗖 🗖 🔀
ø	▼ Sample Site: Point Sample ▼ Sample: All Layers ▼ Show Sampling Ring	
<u>۲</u>	mb2476 Brinham City plate1 Georeferenced.tif @ 72% (Grav/8) * 🗵	44 44
	mb2476_Brigham City_plate1_Georeferenced.tif @ 72% (Gray/8) * ⊠ 23 1 24 1 25 25 26 27 28 27 28 29 30 31 31 32 33 34 35 36 37 38 39 40 41 41 42 42 4 Qab Qat	« « Image: Color swatches Image: Swatches Image: Swatches Image: Swatches
	QIS Qal Qal Qht	 Image: Cancel Auto Options Image: Image: Option Image: O
48 49	71.97% ⓑ Doc: 79.7M/79.6M ► <	

However, when the levels where adjusted for the darker part of the map the lighter part gets faded out. A workaround is to make multiple images.

Easy Map

Challenging Map

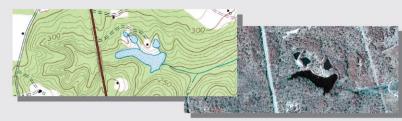


Comparison of the two color levels. The easier map has a wider distribution and more identifiable black colors.

Results

- A faster method to convert non-digital maps to GIS format
- More precise lines comparable to the original map
- Expanding use of image processing (Photoshop, GIMP)
- High quality scanned maps provide great results
- Divide challenging maps processing into workable rasters
- Take advantage of an ArcMap extension
- Move forward on your mapping project

Digital Mapping Techniques



Association of American State Geologists

2015

United States Geological Survey

Thank you

Ben Erickson, M.S., P.G. Hazard Mapping Geologist Utah Geological Survey benerickson@utah.gov 801-537-3379



UTAH GEOLOGICAL SURVEY

geology.utah.gov