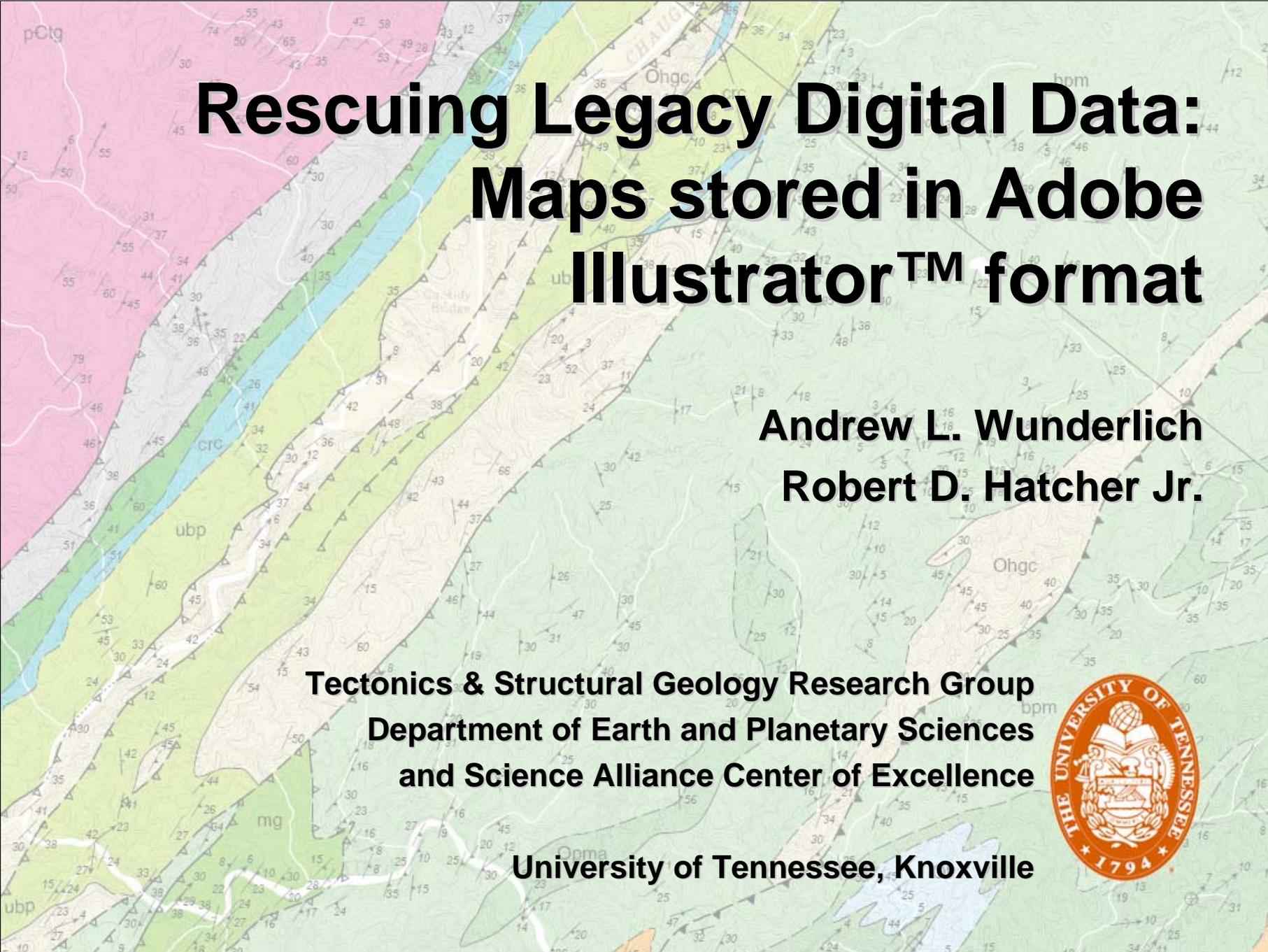


The following was presented at DMT'08
(May 18-21, 2008).

The contents are provisional and will be
superseded by a paper in the
DMT'08 Proceedings.

See also earlier Proceedings (1997-2007)

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

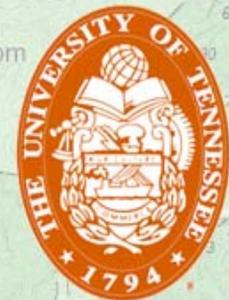


Rescuing Legacy Digital Data: Maps stored in Adobe Illustrator™ format

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Introduction

As GIS databases become the standard for storing spatial data, many organizations may be struggling to integrate “legacy” digital data into modern geospatial databases.

Map information that is stored in older digital data formats without spatial reference or attribution are in danger of being lost for future mapping and analysis purposes if the data are not converted into newer digital geospatial databases.



What are “legacy” data?

- Digital file formats that do not natively accept storage of geospatial information and feature attributes (Adobe Illustrator files)
- Other older, possibly obsolete digital file formats (programs have been discontinued, superseded by another format, etc.)

Also:

- Attribute data in spreadsheet files, field books, etc...
- Analog map formats such as mylar or paper

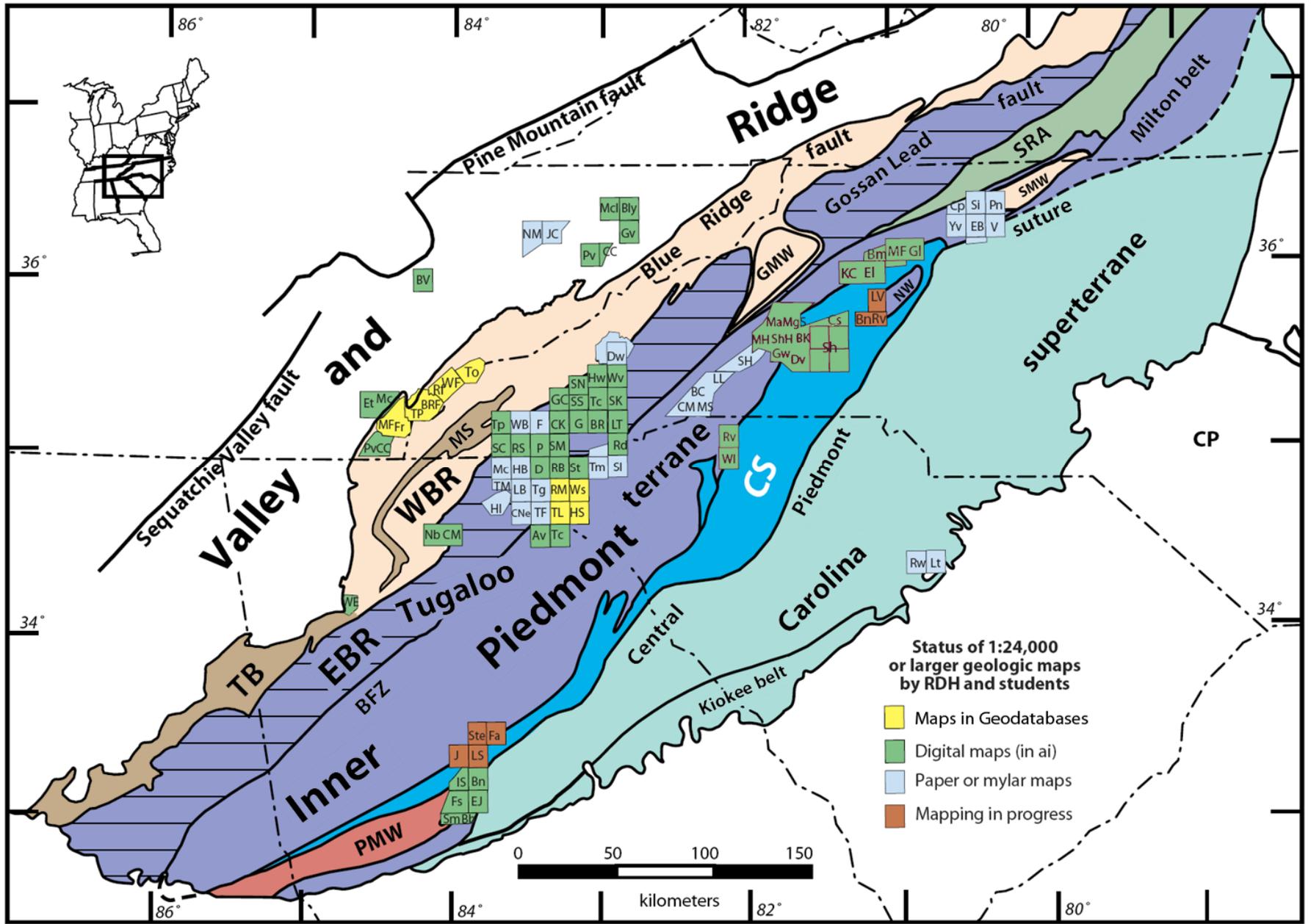




Our Problem...

- Large collection of legacy geologic maps covering over 100 7.5-minute quadrangles.
- Maps are accompanied by a wealth of ancillary information that is not easily accessed. (station maps, field books containing detailed structural data and notes, photographs, etc.)
- Over 40 years of detailed geologic mapping (24K or larger scale) in the southern Appalachians is in danger of slipping into obsolescence...







Our Goal...

Transform and integrate these legacy data into geospatial databases to:

- Prepare current and future analysis and mapping projects (single quad maps, compilations, cross sections, etc.)
- Enhance the chances for long-term survival of the data
- Make the data available to the larger geologic community



Our Response...

Develop a method to convert these legacy digital data from Adobe Illustrator (and others) to a geospatial database that:

- Makes the process modular, clearly defined, and repeatable
- Retains as many of the existing attributes in the legacy files as possible
- Saves time on repetitive tasks by automating certain procedures with customized software tools
- Uses a template geodatabase for better interoperability with other geologic databases





Our Method...

- 1) The original file is cleaned up and organized into layers in Adobe Illustrator and exported to AutoCAD™ drawings. An image of the map is also exported to be used for attribution.
- 2) AutoCAD files are converted to shapefiles and spatially adjusted in ArcMap™ and appended into a geodatabase.
- 3) Geologic point data attributes that were not retained directly are either calculated from the feature (strike/rotation) or added to the features semi-automatically with the help of ArcMap utilities developed in-house (dip/plunge).



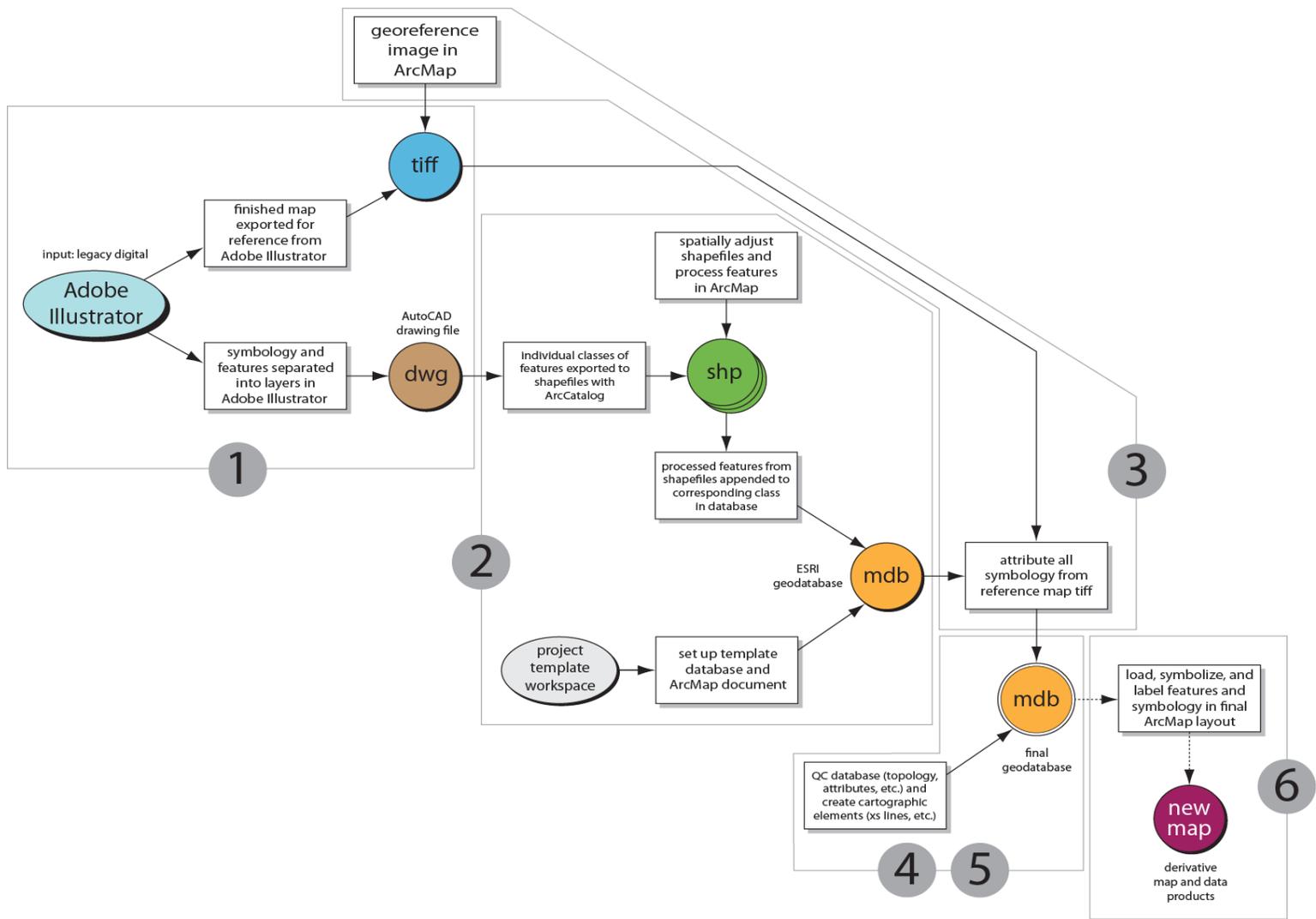


Our Method...

- 4) The entire database is then checked for topology errors, and if the map being processed is adjacent to existing data, the adjoining edges are reconciled.
- 5) A round of quality control measures are taken, including correcting mistaken attribution, after which any special considerations are addressed.
- 6) The finished database is then symbolized, labeled in ArcMap, and exported as a graphic for placement in a final map layout for editing and publication.



Method diagram

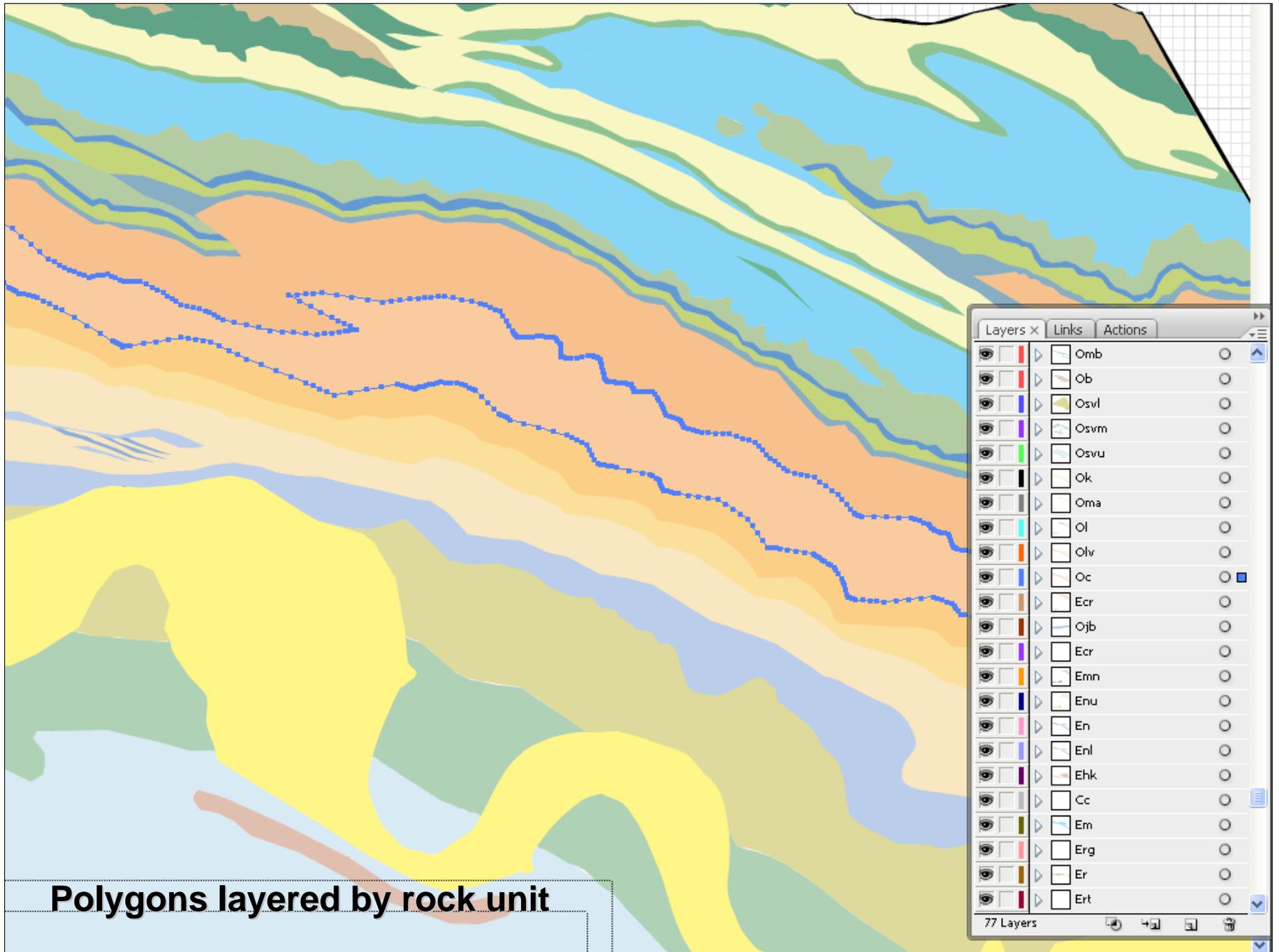




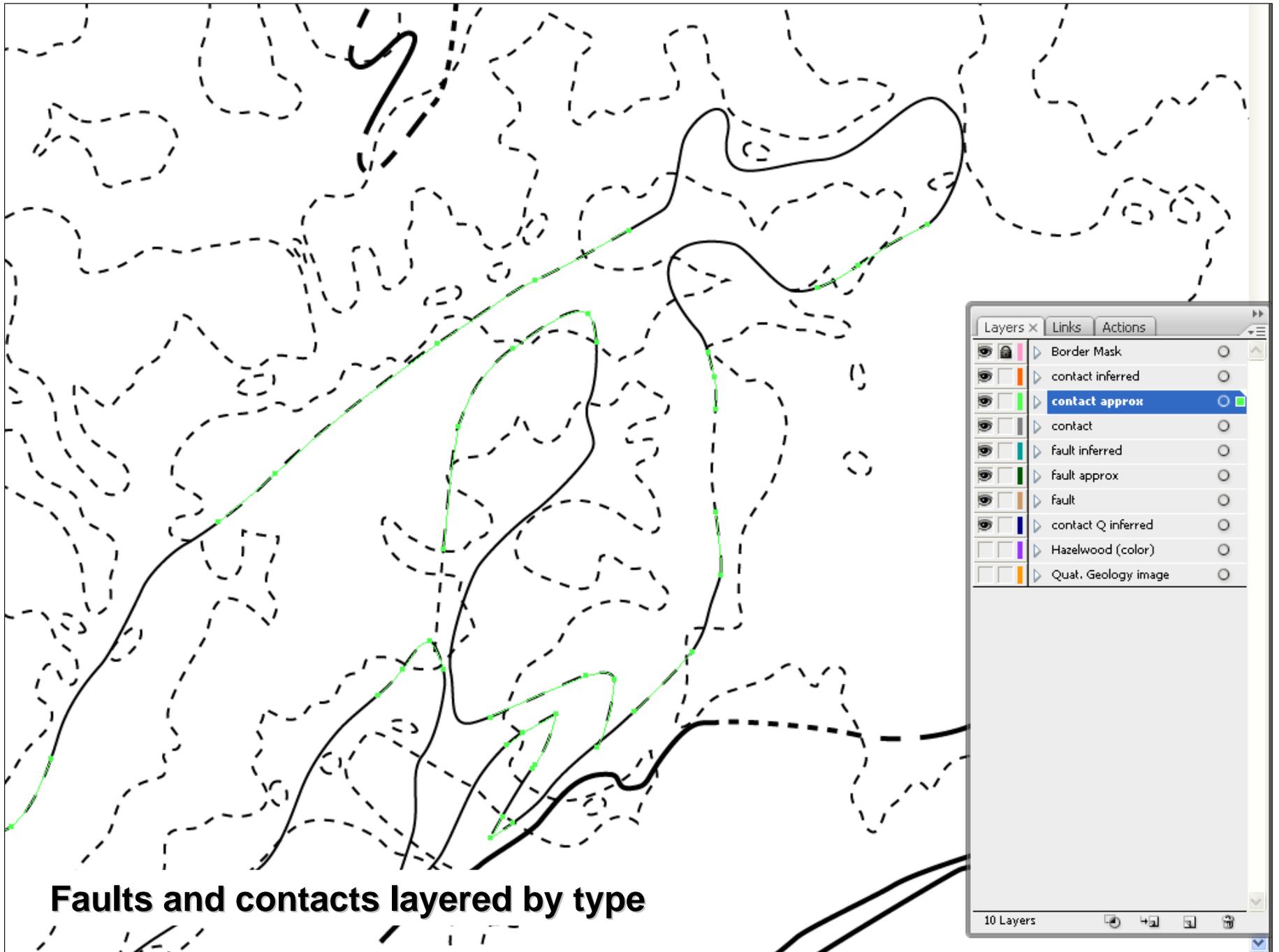
Step 1

- The original file is cleaned up and organized into layers according to feature type in Adobe Illustrator in order to maintain maximum attribution.
- Line and Polygon features are densified and straightened to remove Bezier curves
- Each topological type is individually exported to an AutoCAD™ drawing.
- A TIFF image of the map is also exported to be used for attribution of dip/plunge in Step 3.

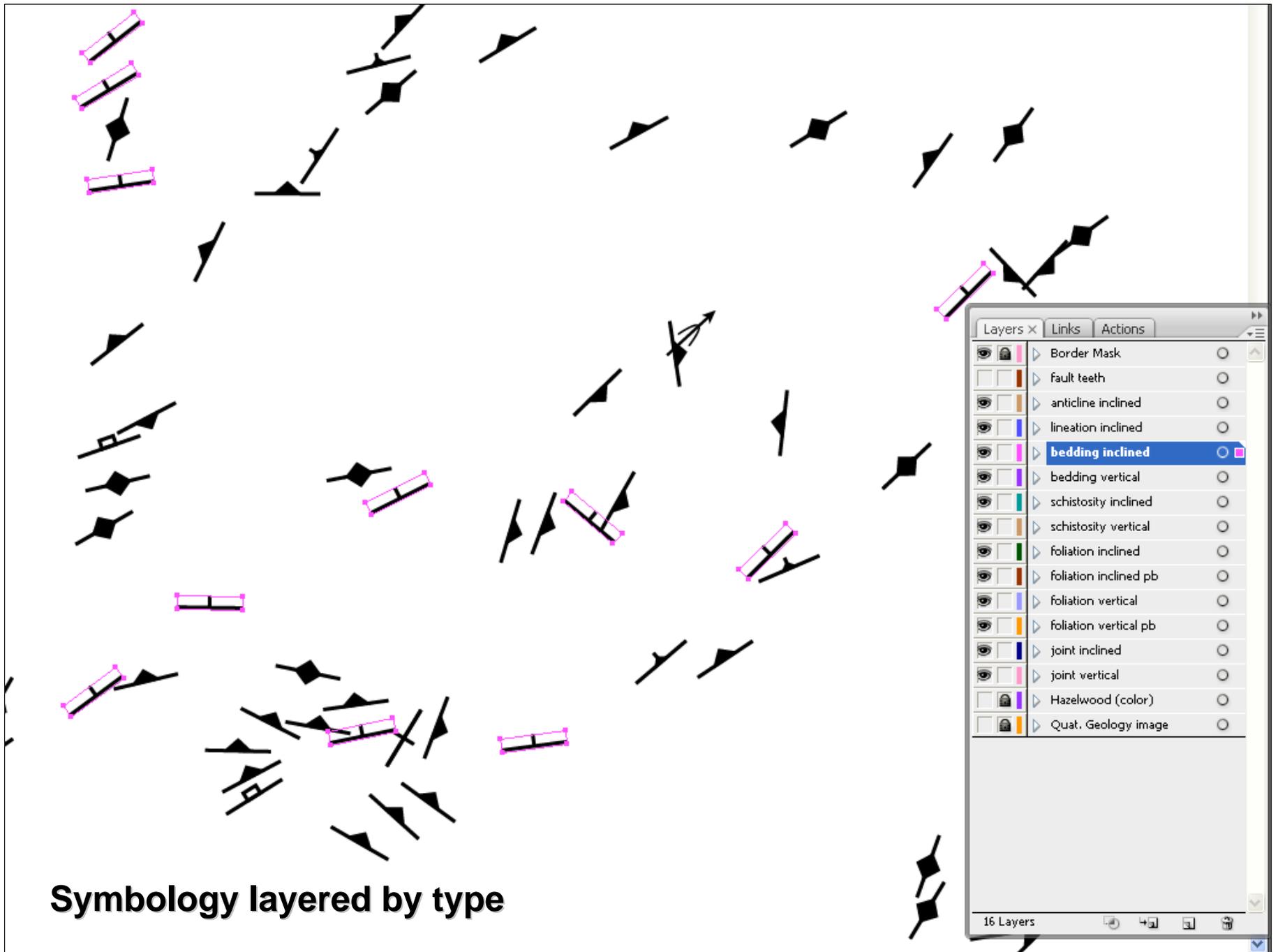




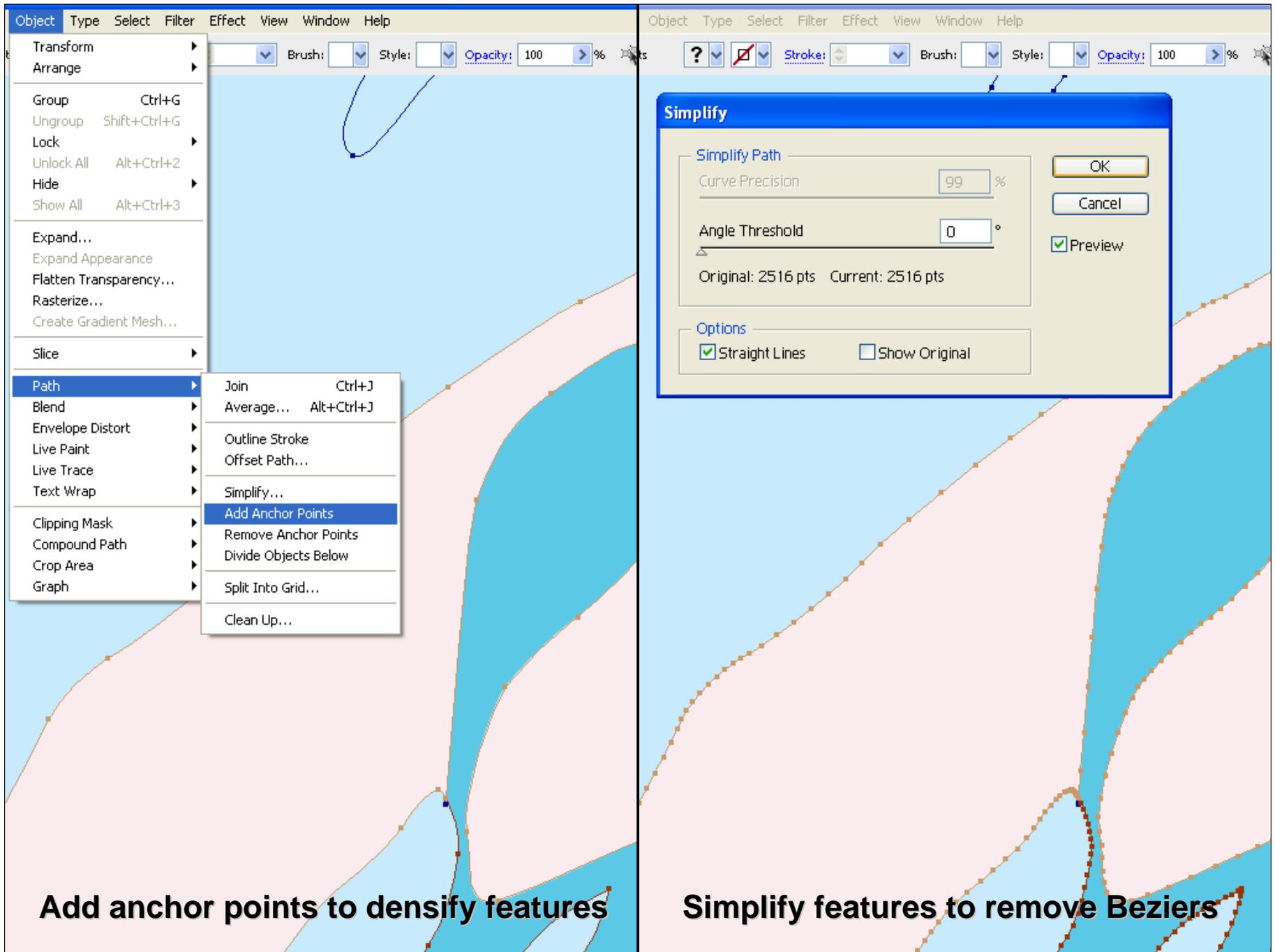
Illustrator file layering of polygons.



Illustrator file layering of lines.



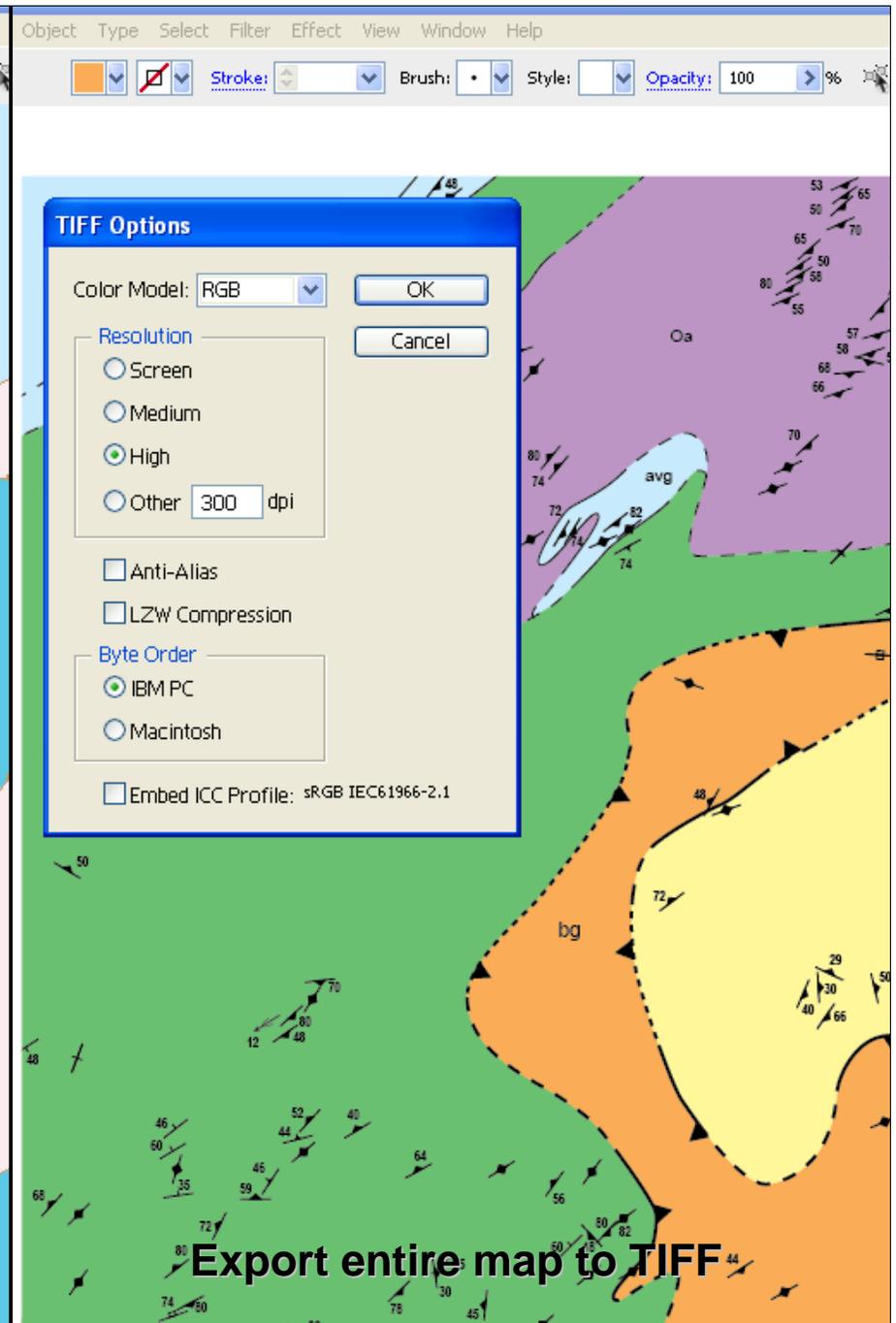
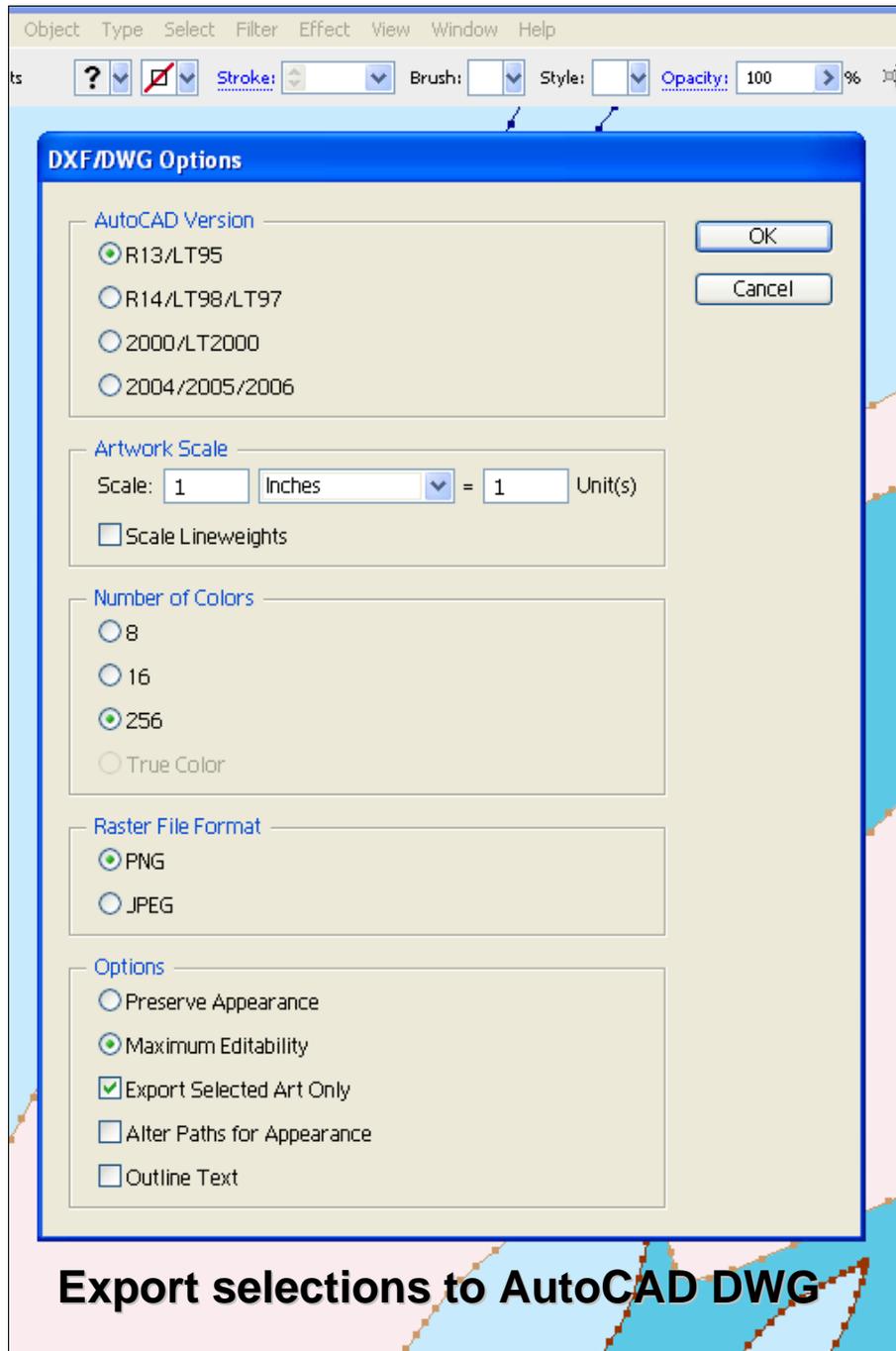
Illustrator file layering of lines.



Add anchor points to densify features

Simplify features to remove Beziers

Densify and simplify



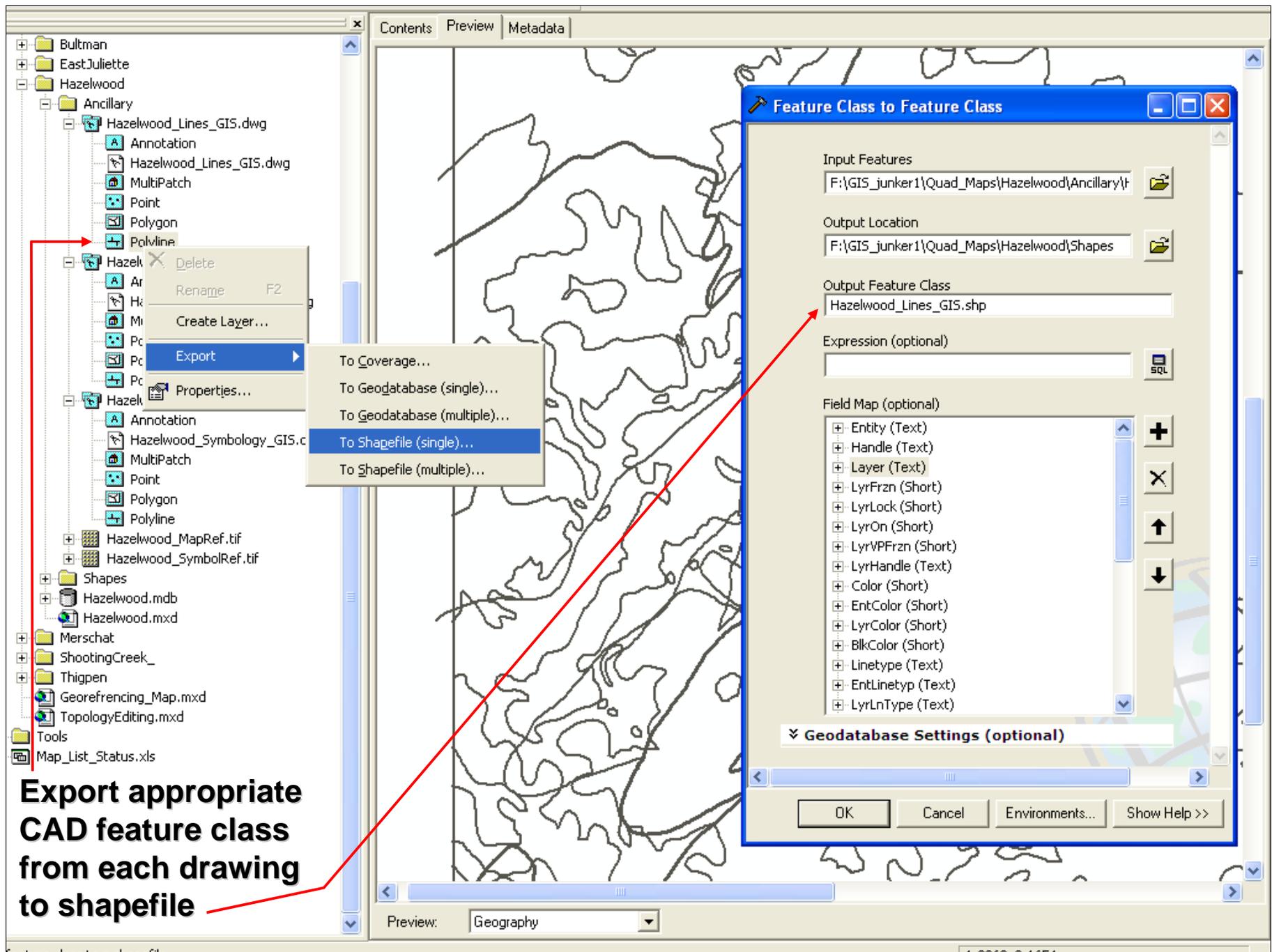
Export to TIFF and export to AutoCAD



Step 2

- AutoCAD files are checked in ArcCatalog for errors. (If found, back to Step 1)
- Selected feature classes within each AutoCAD file are converted to shapefiles.
- The shapefiles are spatially adjusted in an ArcMap edit session using the quadrangle boundary as a guide
- The adjusted shapefiles are saved and appended to their corresponding feature classes in a geodatabase





AutoCAD class tree and export to shape dialog

Exported shapefiles are loaded into ArcMap and spatially adjusted by snapping the corners of the footprint to the corners of a projected quadrangle boundary (HW_Footprint).

Note the small residual error (in meters)

Spatial Adjustment

Snapping Environment

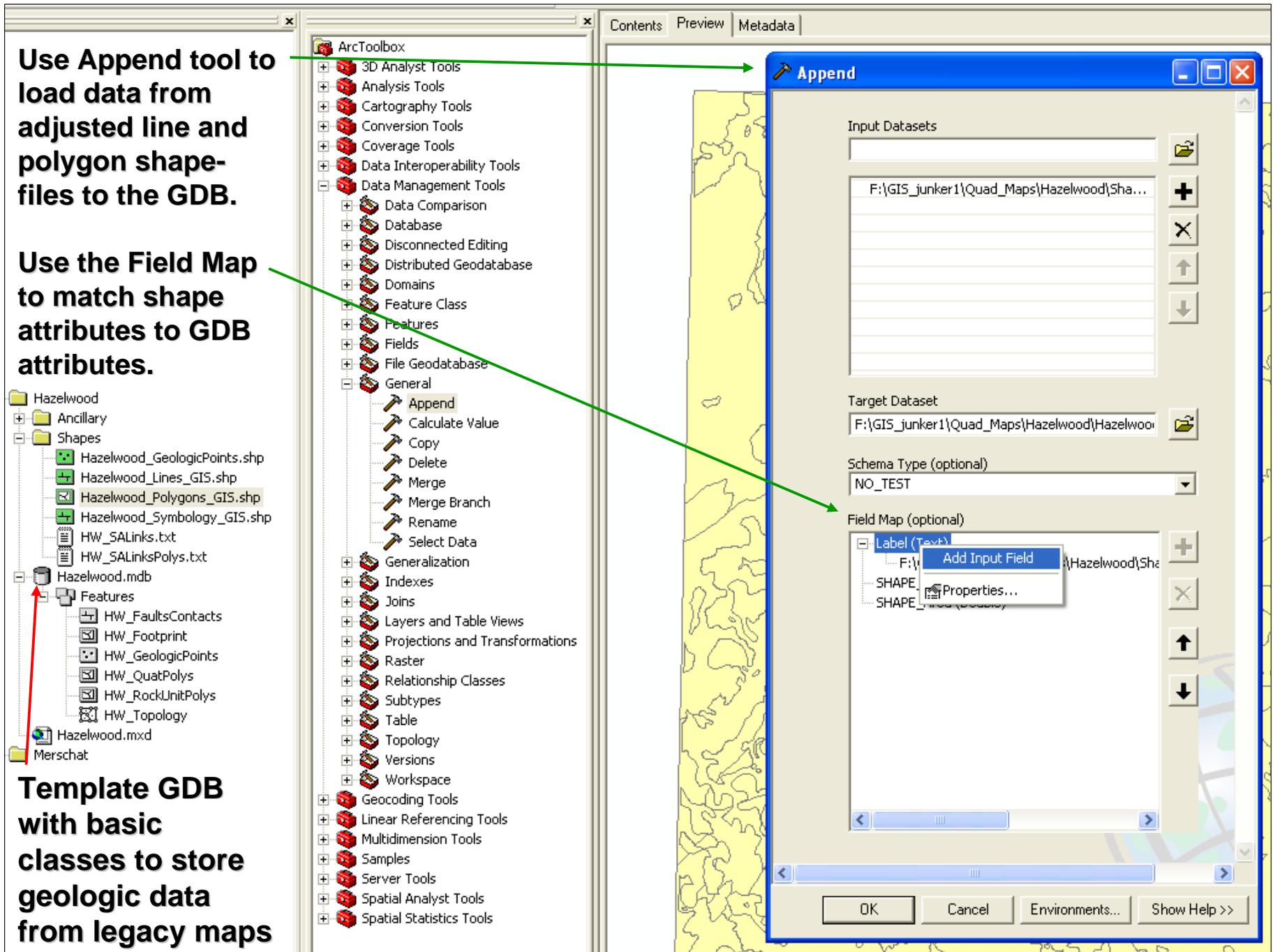
Layer	Vertex	Edge	End
Hazelwood_Lines_GIS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hazelwood_Symbology_GIS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HW_Footprint	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hazelwood_Polygons_GIS	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Link Table

ID	X Source	Y Source	X Destination	Y Destination	Residual Error
4	382.974384	-188.856689	318316.707500	3916267.538600	1.312302
3	-100.209215	-188.856689	306959.770500	3916504.722600	1.312302
2	382.623329	398.405484	318597.415600	3930133.417400	1.313736
1	-100.032826	398.405484	307258.121800	3930370.527500	1.313736

RMS Error: 1.313019

Spatial adjustment in ArcMap



ArcCatalog toolbox and Append to Geodatabase showing tree



Step 3

- Symbology shapefile is processed in ArcMap and any unnecessary features are flagged as unneeded (operator intensive).
- Strike/rotation attribute is calculated for each feature using an ArcMap Field Calculator expression.
- Dip/plunge attribute (if applicable) is read from reference TIFF image and added to each feature semi-automatically by an operator with the help of an ArcMap utility developed in-house (AttributeFeatures tool)



Symbology shapefile needs to be processed to flag unnecessary features so they are not appended to database

Select by Attributes

Enter a WHERE clause to select records in the table window.

Method: Create a new selection

"FID"
"Entity"
"Handle"
"Label"
"Length"
"Keep"

= <> Like 31.4012043286
> >= And 31.4010810753
< <= Or 31.3419827247
_ % () Not 31.3394039987
31.3489919011
31.3469794716
31.3513729377

Is Get Unique Values Go To:

SELECT * FROM TugalooLake_SymbologyGIS WHERE:
("Length" > 58.035917 AND "Length" <= 72.017166) OR ("Length" > 78.017377 AND "Length" <= 101.966996) OR ("Length" > 141.109499)

Clear Verify Help Load... Save...
Apply Close

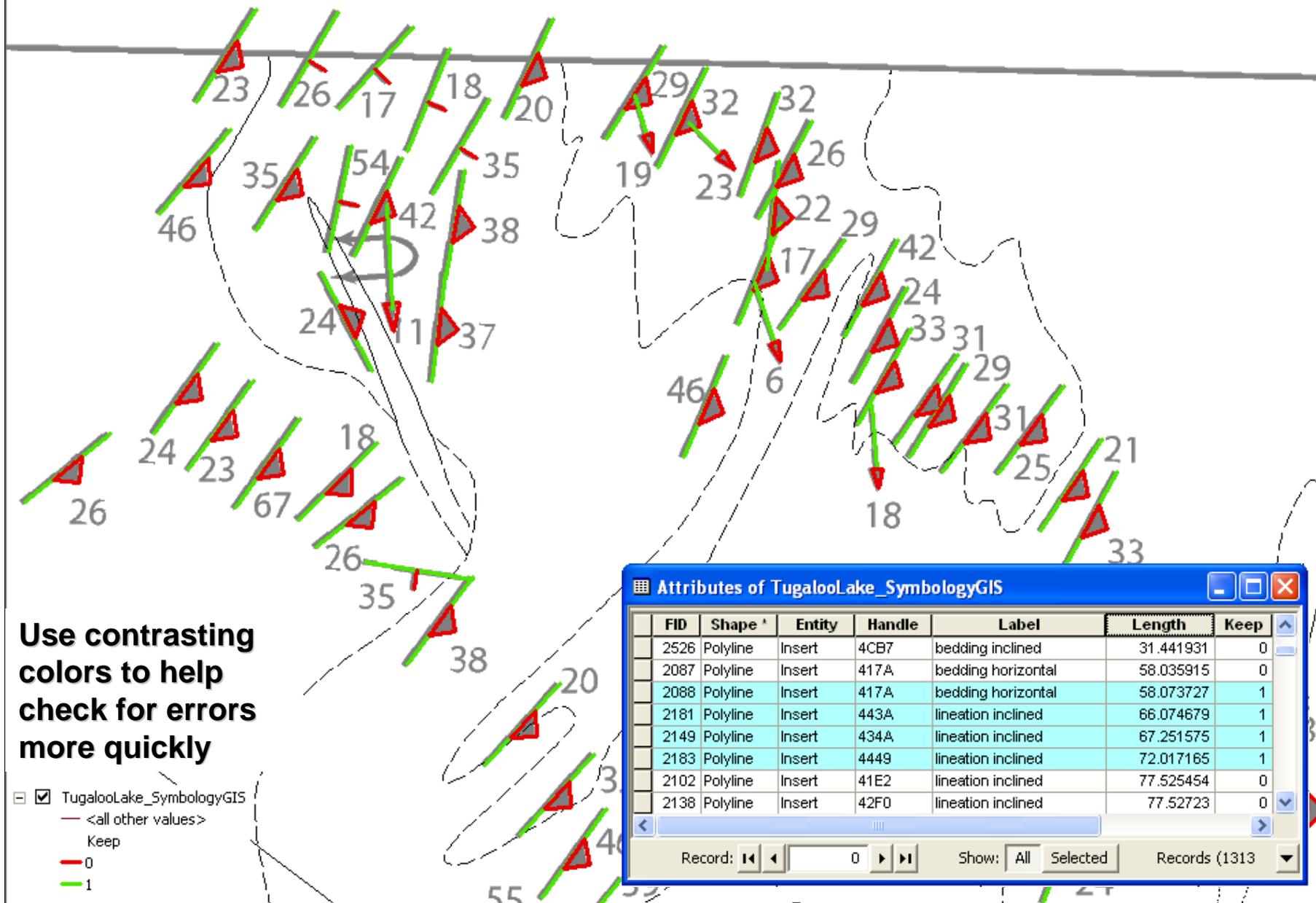
Use the 'Length' attribute to select features that are not needed.

Attributes of TugalooLake_SymbologyGIS

FID	Shape	Entity	Handle	Label	Length
2264	Polyline	Insert	4693	bedding inclined	31.339404
2260	Polyline	Insert	467B	bedding inclined	31.341965
2262	Polyline	Insert	4687	bedding inclined	31.341983
2268	Polyline	Insert	464B	bedding inclined	31.346979
2258	Polyline	Insert	466F	bedding inclined	31.348594
2272	Polyline	Insert	46C3	bedding inclined	31.348874
2266	Polyline	Insert	469F	bedding inclined	31.348992
2270	Polyline	Insert	46B7	bedding inclined	31.351373

Record: 0 Show: All Selected Records

Don't delete anything! Use attributes to flag features. Mistakes can be fixed later...



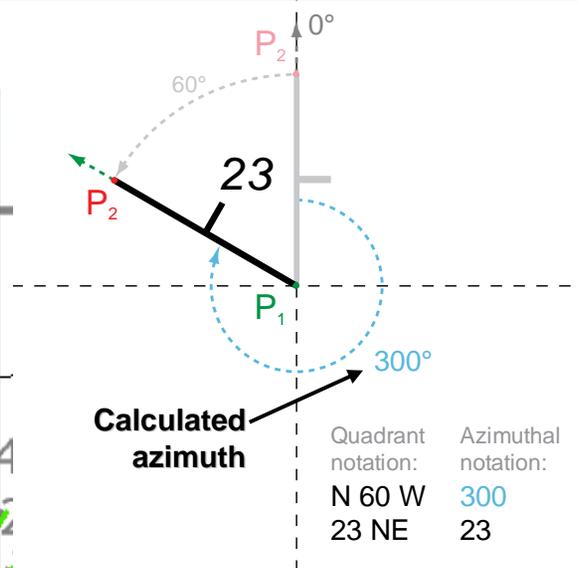
Use contrasting colors to help check for errors more quickly

- TugalooLake_SymbologyGIS
- <all other values>
- Keep
- 0
- 1

Symbology cleanup in ArcMap 2

FID	Shape	Entity	Handle	Label	Length	Keep	Strike
876	Polyline	Insert	1B99	foliation inclined	139.415731	0	0
882	Polyline	Insert	1BC9	foliation inclined	139.41986	0	0
874	Polyline	Insert	1B89	foliation inclined	139.42361	0	0
22	Polyline	Insert	E9	foliation inclined	141.0915	0	0
2086	Polyline	Insert	4169	foliation inclined	141.109497	0	0
2550	Polyline	Insert	4D99	anticline overturned	161.430178	1	357
2552	Polyline	Insert	4DB2	anticline overturned	161.465223	1	225
2554	Polyline	Insert	4DCB	anticline overturned	161.521383	1	331
2562	Polyline	Insert	4E2F	anticline overturned	161.542345	1	40
2556	Polyline	Insert	4DE4	anticline overturned	161.543584	1	211

- Sort Ascending
- Sort Descending
- Summarize...
- Statistics...
- Field Calculator...**
- Calculate Geometry...
- Turn Field Off
- Freeze/Unfreeze Column
- Delete Field
- Properties...



Field Calculator

Fields: FID, Entity, Handle, Layer, Label, Length, Strike

Type: Number, String, Date

Functions: Abs (), Atn (), Cos (), Exp (), Fix (), Int (), Log (), Sin (), Sqr ()

Pre-Logic VBA Script Code Advanced

```
'=====
'polyline_Get_Azimuth_9x.cal
'Author: Ianko Tchoukanski
'http://www.ian-ko.com
'=====
On Error Resume Next
```

Strike = dAngle

Calculate selected records only

Data loaded.

Buttons: Load..., Save..., Help, OK, Cancel

With "Keep=1" features selected (green), use the Field Calculator on the 'Strike' field to determine the azimuthal rotation (see the azimuth example upper-right).

This number is used to rotate the symbol later when it is point-based.

ArcMap Field Calculator for strike/rotation

Once symbology shapefile has been processed, it can be converted to points and appended to the 'GeologicPoints' class in the GDB.

Feature To Point

Input Features
lazelwood\Shapes\Hazelwood_Symbology_GIS.shp

Output Feature Class
lazelwood\Shapes\Hazelwood_GeologicPoints.shp

Inside

OK Cancel Environments... Show Help >>

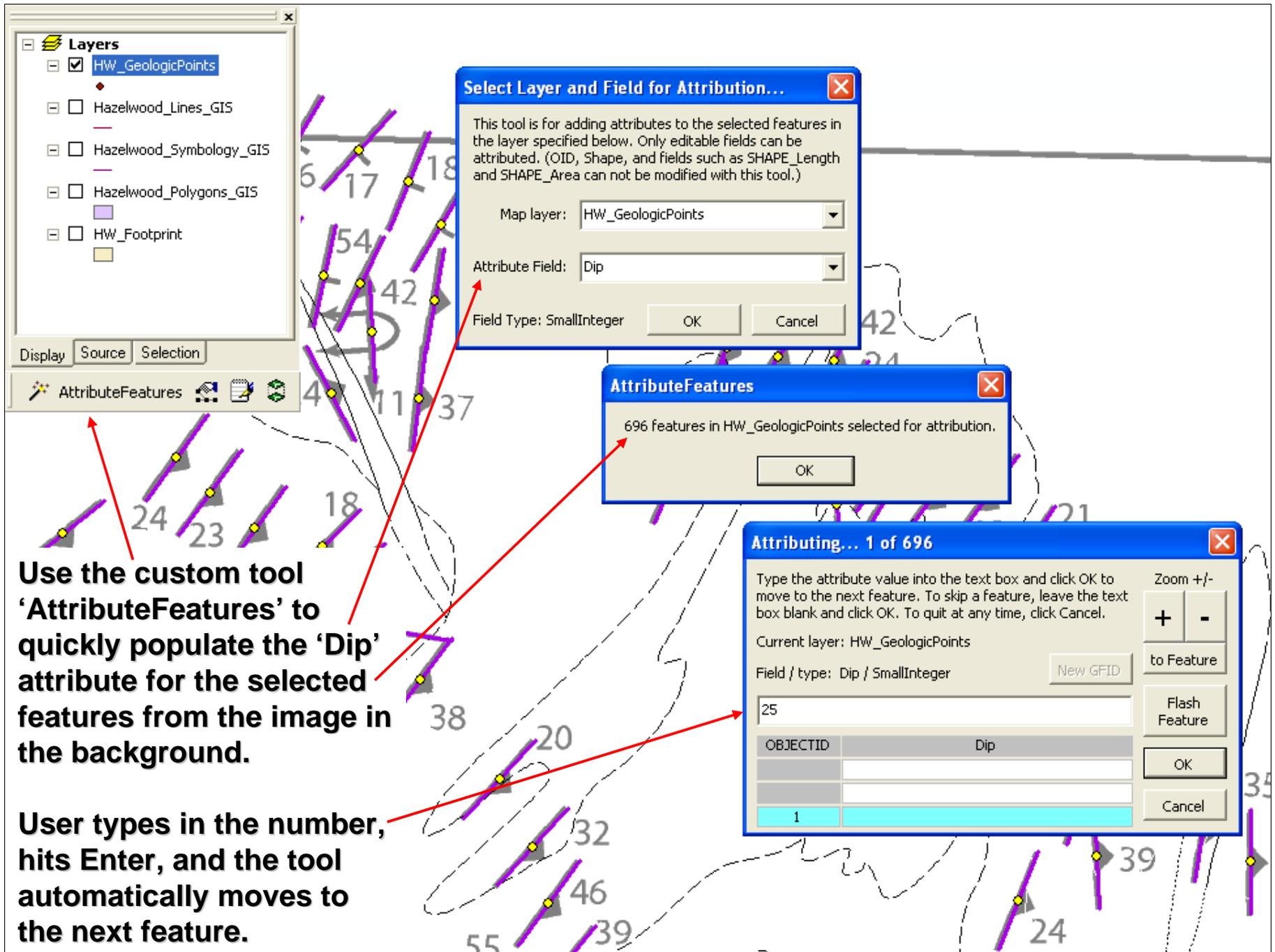
Some points will need to be snapped to their station locations

Layers

- HW_GeologicPoints
- Hazelwood_Lines_GIS
- Hazelwood_Symbology_GIS
- Hazelwood_Polygons_GIS
- HW_Footprint

Display Source Selection

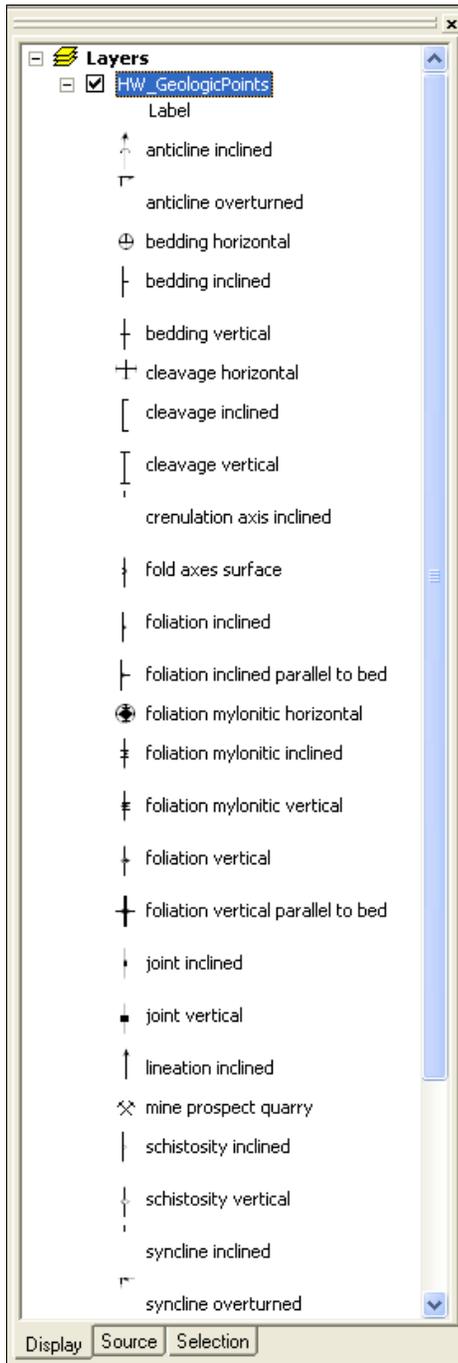
Symbology convert to points in ArcMap



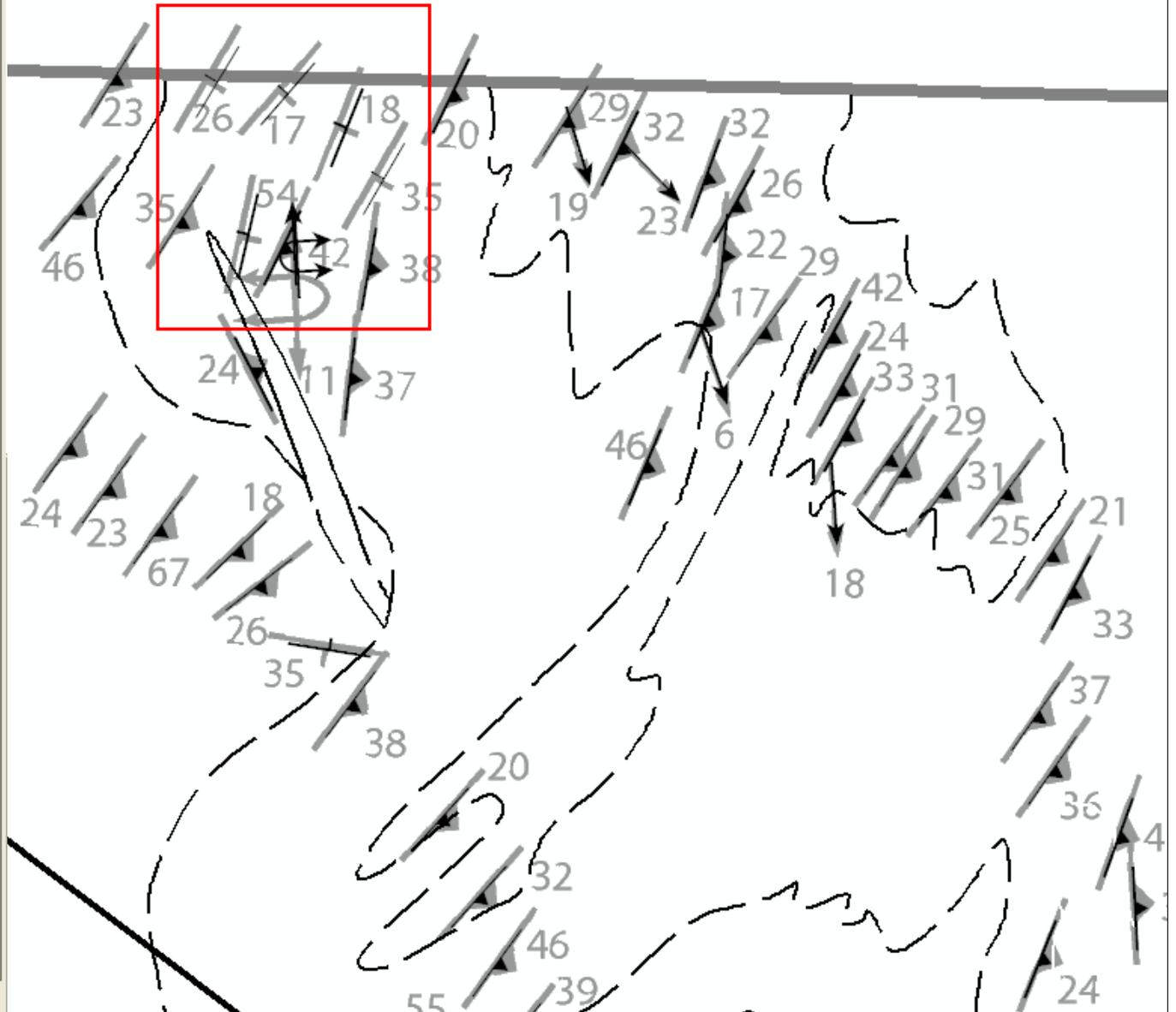
Use the custom tool 'AttributeFeatures' to quickly populate the 'Dip' attribute for the selected features from the image in the background.

User types in the number, hits Enter, and the tool automatically moves to the next feature.

Attribute Features tool



After attribution, the points are symbolized and the rotation checked. Note the inversion of the inclined bedding and overturned antiform symbols. These will have to be corrected.



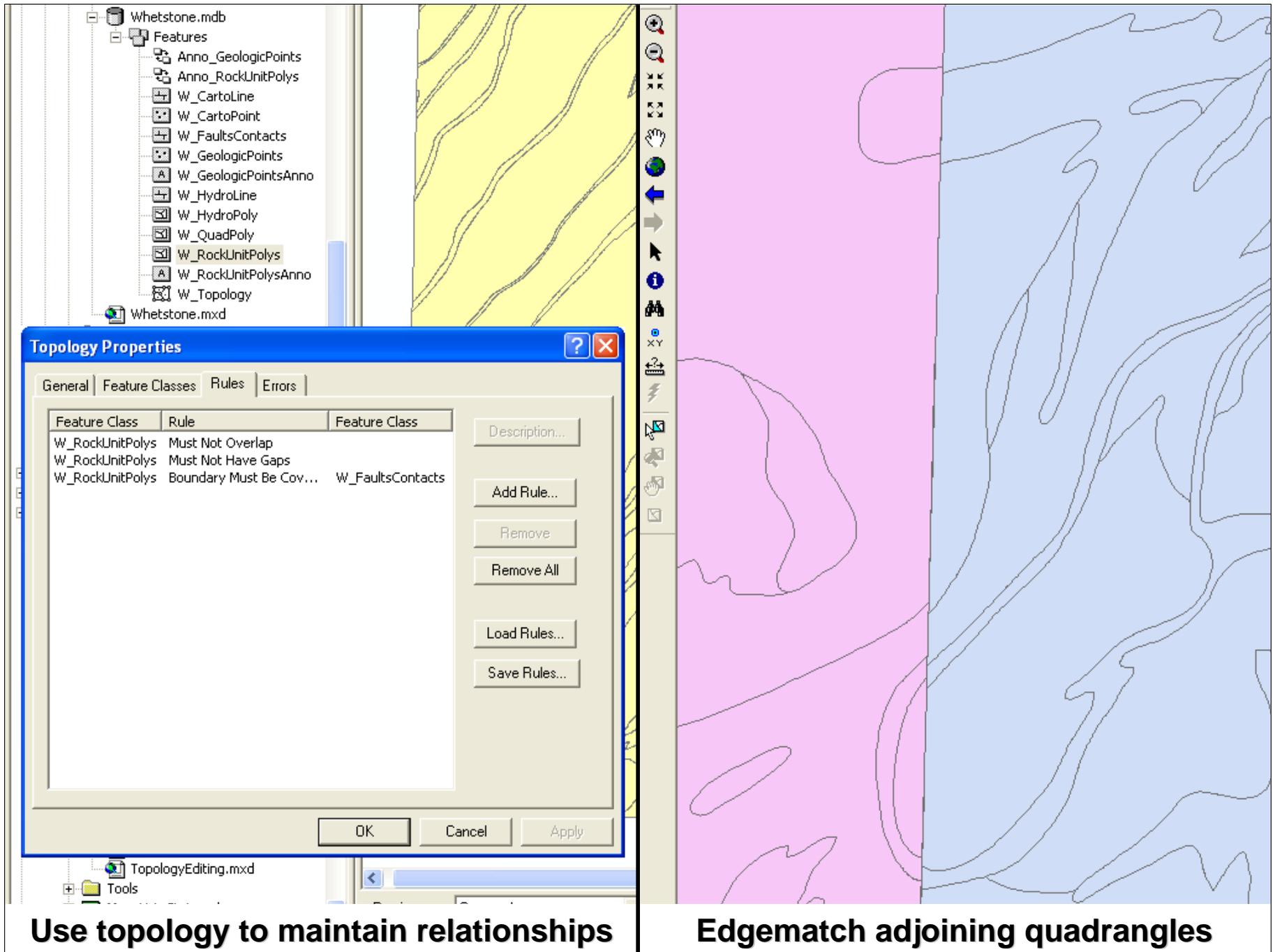
Symbolize and check for errors



Steps 4, 5, and 6

- The database is checked for topology errors and edge-matched to existing data if necessary.
- A round of quality control measures are taken and any special considerations are addressed.
- The database is ready for symbolization and labeling in ArcMap, and can be exported for placement in a final map layout for editing and publication.





Use topology to maintain relationships

Edgematch adjoining quadrangles

Topology rules/Edgematching



QC and Special Items

- Quality control can consist of:
 - Checking tables for <null> or incorrect attributes and fixing if found.
 - Comparing to reference map or checking field books to confirm correct attributes.
- Special cartographic or other items:
 - Labels are converted to annotation so they can be positioned by hand.
 - Cross-section lines, label points, fault names, fault teeth, etc. are created and stored.
 - Any other items specific to a particular map.

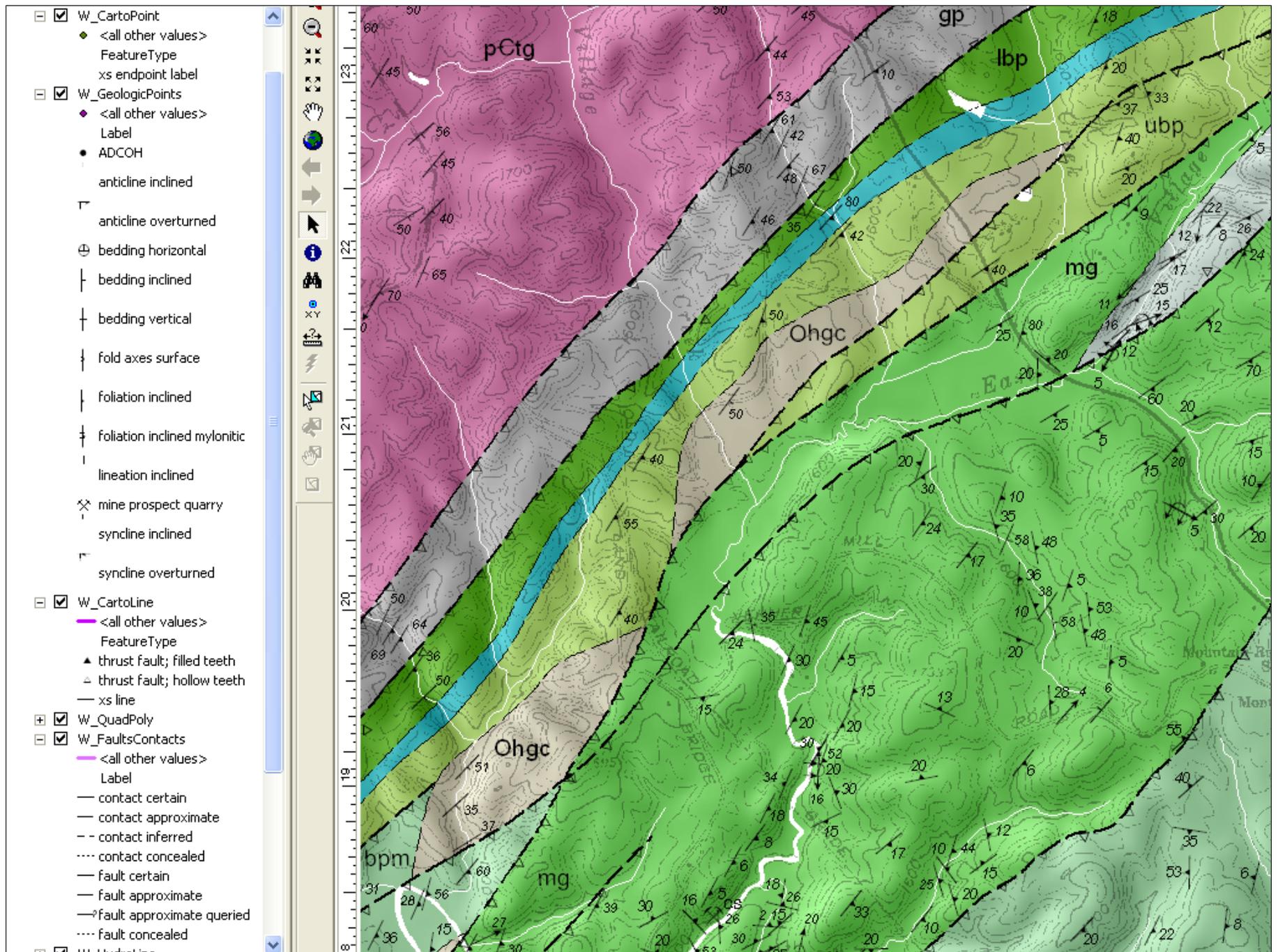




Map symbology and export

- The data are loaded into a template ArcMap layout and the layers are arranged appropriately.
- Layer files allow for implementation of standards and provide consistent replication of colors and symbols.
- DRGs, hillshades, or other data can be added to the map.
- Exports to PDF, Illustrator, or TIFF for placement in a layout for print or editing.





Final map and labels in ArcMap

Final Thoughts

- Modular aspect makes it easier for multiple operators to work simultaneously.
- Method is less labor intensive than scratch digitizing, but requires greater care by operator not to lose or change data.
- Process can be tweaked to work with other input formats and different outputs (SDE, ArcIMS, etc.)





Future Developments

- Find a way to link CAD annotation to features to speed attribution.
- Could be automated further if AI files could be dissected programmatically.
- Other suggestions?





**Thank you for your time
and attention!**

Questions?