DIGITAL MAPPING TECHNIQUES 2024

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Suggestions for GeMS compliance of IsoValueLine data

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The original GeMS documentation (U.S. Geological Survey National Cooperative Geologic Mapping Program, 2020) described IsoValueLines as an as-needed line feature class in the GeologicMap feature dataset. The description of the feature class was purposely written in a general fashion, and was intended to encompass all varieties of contoured data such as structure contours, concentration isopleths, and hydraulic-head contours. With some minor modification, the IsoValueLines feature class can be made much more specific to, and useful for, subsurface geologic mapping and can be part of a GeMS spatial geodatabase GDB that validates at GeMS Level 3.

Minor changes are suggested for the GeMS IsoValueLines schema to enhance usability for subsurface mapping, including:

- **Add MapUnit as a field in the IsoValueLines attribute table**: As with MapUnitPolys, the addition of the normally required field MapUnit forces a foreign key relationship to a DescriptionOfMapUnits table, thus requiring the author to create a DOMU. This is a boon to subsurface mapping where a contour map is often presented with little explanation of the nature of the geologic unit being mapped.
- **Make explicit use of the Type attribute field and link to a Glossary:** Authors could be encouraged to add detail in the "Type" attribute to not only list as "Structure Contour" but explicitly include whether it is the top or base of the unit that is being contoured. Similarly, thickness maps could be more explicitly described as isochore (apparent thickness) vs isopach (true thickness). Terms would be defined in a glossary as normal.
- **Addition or replacement of the "Value" field:** Beyond a single "Value" field, authors should consider being explicit in the attribute table about units of measurement and whether the measurement is a depth, elevation, or thickness value. Authors may consider using dual columns showing value in feet and also in meters, since these are a common point of error or confusion in subsurface data. Possibilities include a column such as "Value_ft", two columns such as "Value_ft" and "Value_m", or "Elevation_ft" or Depth_ft". Subsurface data become more usable if there is clarity of what the contours represent, and their unit of measure is built directly into the attribute table, without the need to always have to refer to a nonspatial table.
- **Completing GeMS nonspatial tables for IsoValueLines:** if the author completes a DOMU and Glossary as described above, it is a simple matter to also complete a DataSources table and add the GeoMaterialsDictionary such that all required nonspatial tables are present in the GDB.

To take advantage of the GeMS database validation tools, a subsurface map must have the required ContactsAndFaults and MapUnitPolys feature classes present. Three examples are presented that show various use cases of how these feature classes might be created. In subsurface mapping of the Wilcox Group of the Gulf Coast (Sweetkind and Warwick, 2022), outcrop polygons of the mapped unit are included with the contoured data, which leads to the creation of both ContactsAndFaults and MapUnitPolys feature classes. In a data release of modeled horizon tops from a 3D framework model of the Anadarko Basin (Zellman and Sweetkind, 2023), faults are the only geologic element to accompany raster data from each modeled horizon; in this case a minimum bounding polygon that defines the model domain could be used as a Contact line in ContactsAndFaults and converted to a polygon in MapUnitPolys. In mapping the elevation of top of Precambrian rocks from previous USGS studies of the Colorado Plateau (Sweetkind and others, 2020), elevation control points are released as a generic point feature class with the IsoValueLines; control points come from a variety of data types, attributed using the TYPE field and linked to a DataSources nonspatial table.

After completing the above the nonspatial tables and creating the required ContactsAndFaults and MapUnitPolys feature classes, the GeMS geodatabase may be able to be run through both the GeMS validation tool and the GeoLex geologic names tool which facilitate error identification and rectification similar to any other geologic map.

Sweetkind, D.S., and Warwick, P.D., 2022, Digital subsurface data from previously published contour map of the top of the Wilcox Group, northern Gulf of Mexico coastal region: U.S. Geological Survey data release, https://doi.org/10.5066/P973641H

Sweetkind, D.S., Ogilvie, I., and Simon, J., 2020, Elevation of top of Precambrian rocks from previous USGS studies of the Colorado Plateau: U.S. Geological Survey data release, https://doi.org/10.5066/P9MDEW0D

U.S. Geological Survey National Cooperative Geologic Mapping Program, 2020, GeMS (Geologic Map Schema)—A standard format for the digital publication of geologic maps: U.S. Geological Survey Techniques and Methods, book 11, chap. B10, 74 p., https://doi.org/10.3133/tm11B10

Zellman, K.L., and Sweetkind, D.S., 2023, Digital database of previously published subsurface unit tops from a 3D Model of the Anadarko Basin Province: U.S. Geological Survey data release, https://doi.org/10.5066/P9EY9IYX

Suggestions for GeMS compliance of IsoValueLine data

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Modifications to IsoValueLines specific to subsurface mapping

- Add MapUnit to the attribute table and create a DOMU

- Be explicit in use of "Type" field and link to Glossary

  - Not just "structure contour", specify unit top vs unit base

  - Specify isochore vs isopach

- Be explicit in use of "Value" field, or add other fields

  - Value_ft or Value_m

  - Elevation_ft vs Depth_ft

These additions get you all of the nonspatial tables required by GeMS

DataSources

Subsurface map data should list data sources just as a surface map does

Glossary

Define terms, be specific!

DOMU

Subsurface map units should be tied to a normal DOMU table that describes the unit being mapped

Top of Wilcox Group map -- IsoValueLines with surface outcrops

In this example, structure contours of the top of the Wilcox Group are combined with outcrop polygons of that unit (plus "not mapped" areas) that populate the ContactsAndFaults and MapUnitPolys feature classes.

This GDB validated at GeMS level 3

Sweetkind, D.S., and Warwick, P.D., 2022, Digital subsurface data from previously published contour map of the top of the Wilcox Group, northern Gulf of Mexico coastal region: U.S. Geological Survey data release, https://doi.org/10.5066/P973641H

Outcrop contacts and polygons
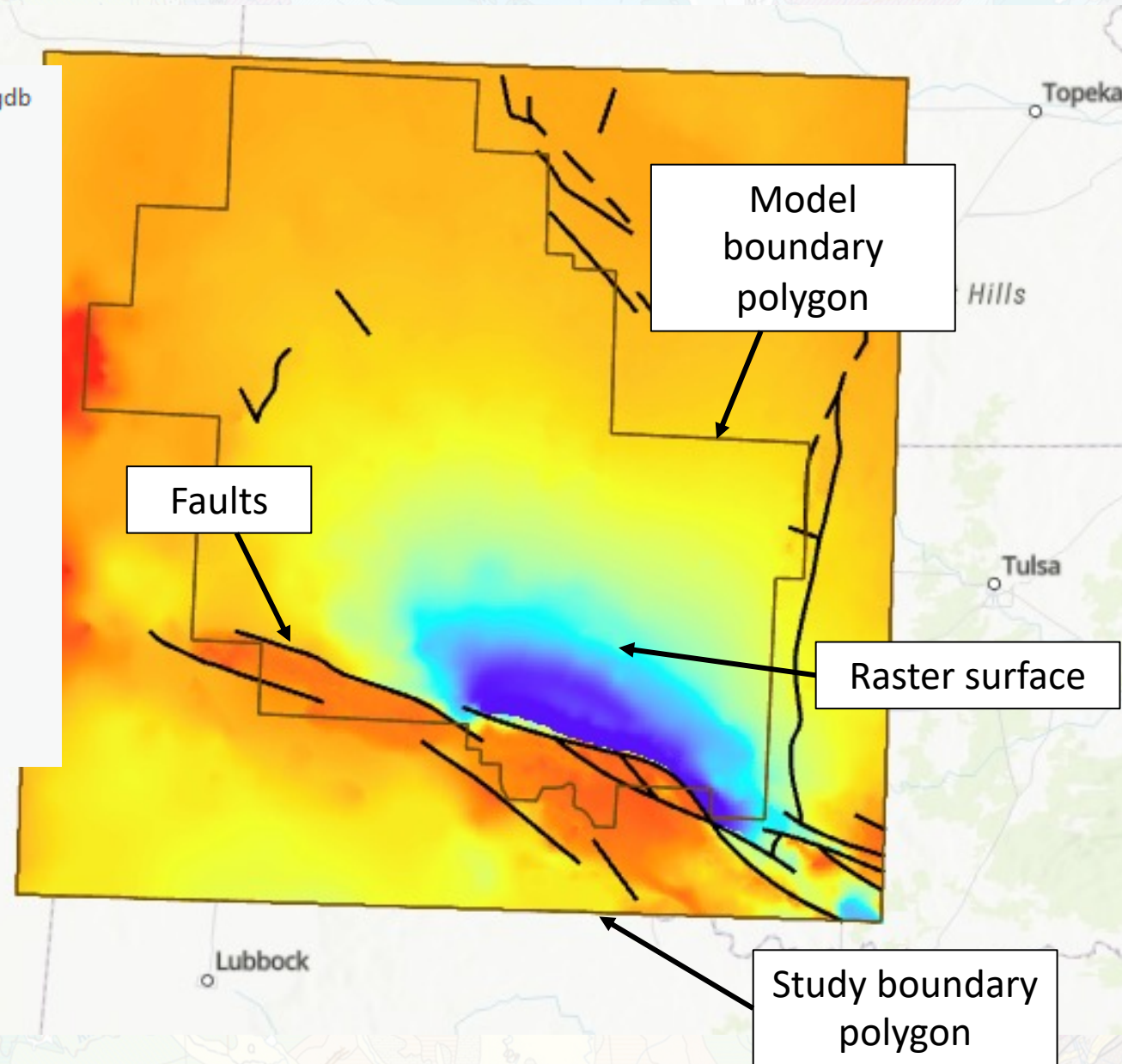
IsoValueLines

"Not mapped" polygon
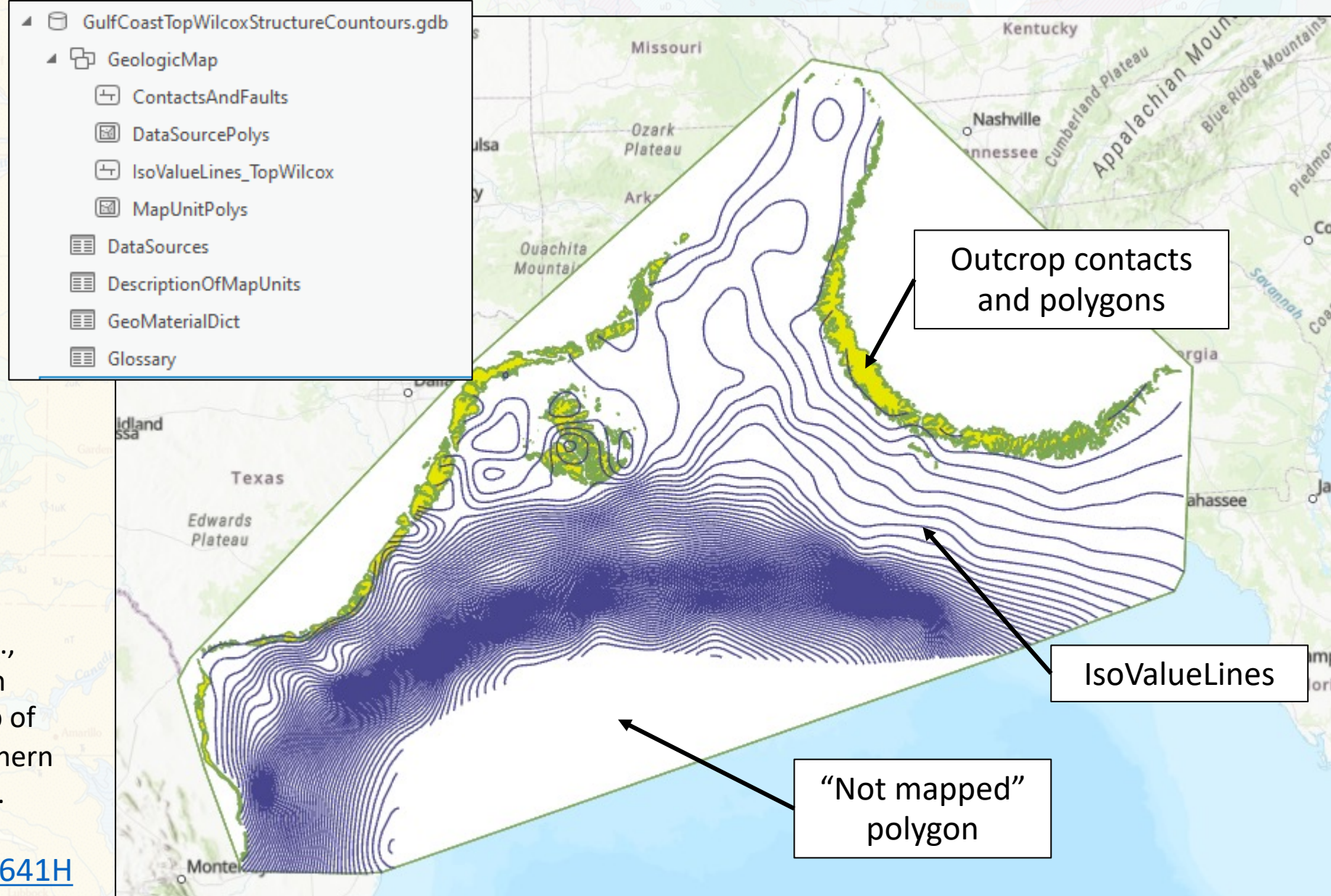
Anadarko Basin model – Raster surfaces with faults and a boundary

In this example, modeled horizon tops from a 3D framework model are released as rasters in a GDB. Faults, the model boundary, and a rectangular study area boundary populate the ContactsAndFaults and MapUnitPolys feature classes.
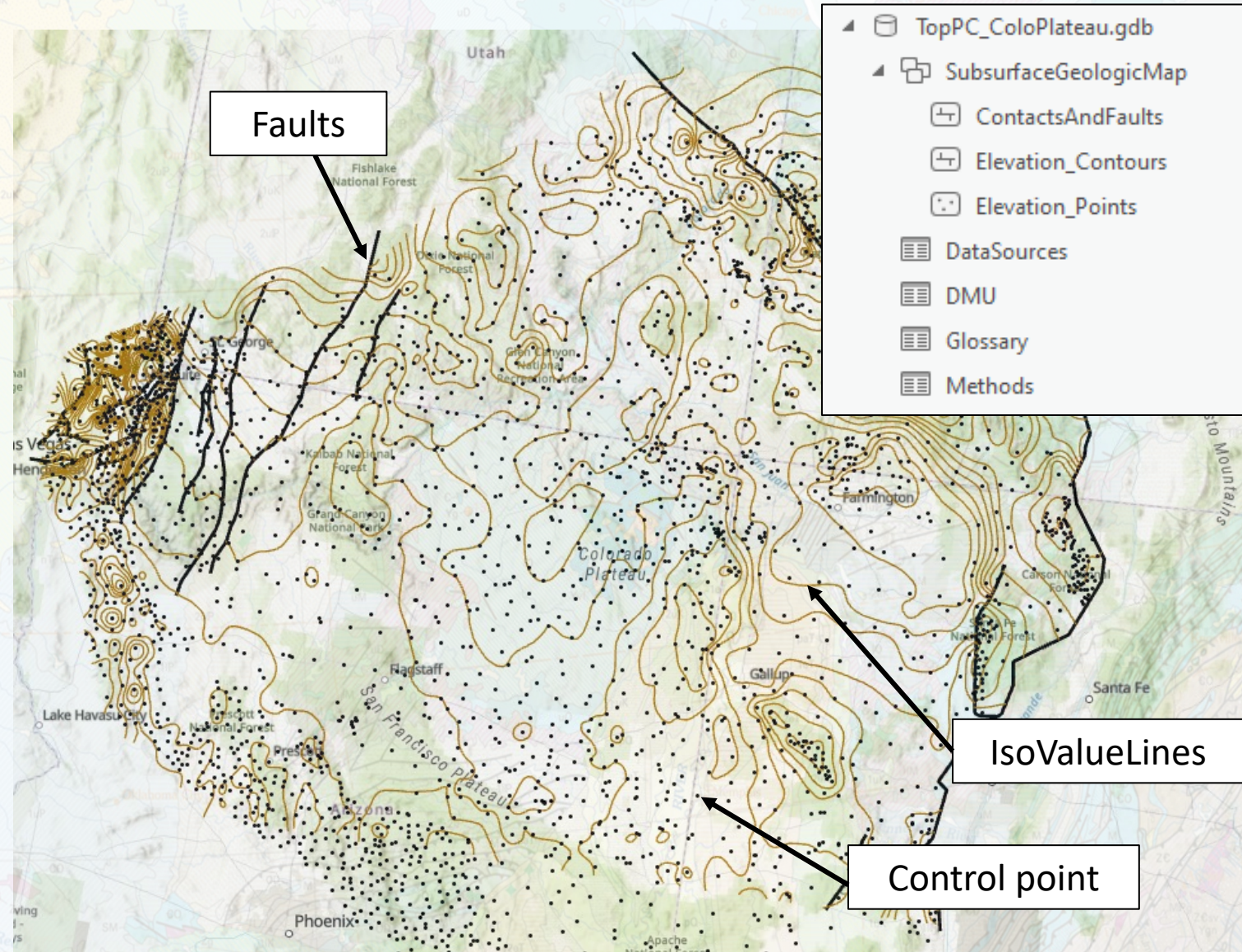
This GDB validated at GeMS level 3

Zellman, K.L., and Sweetkind, D.S., 2023, Digital database of previously published subsurface unit tops from a 3D Model of the Anadarko Basin Province: U.S. Geological Survey data release, https://doi.org/10.5066/P9EY9IYX

Colorado Plateau – IsoValueLines with faults and control points

Ohio Geological Survey has suggested adding an optional field within the Stations feature class used to define elevation measurements from different sources: geophysical data points, water well log, oil-and-gas well log

In this example, elevation control points are released with the IsoValueLines; control points come from a variety of data types, attributed using the TYPE field and linked to a DataSources nonspatial table.

Sweetkind, D.S., Ogilvie, I., and Simon, J., 2020, Elevation of top of Precambrian rocks from previous USGS studies of the Colorado Plateau: U.S. Geological Survey data release, https://doi.org/10.5066/P9MDEW0D

Faults

IsoValueLines

Control point

- TopPC_ColoPlateau.gdb
  - SubsurfaceGeologicMap
    - ContactsAndFaults
    - Elevation_Contours
    - Elevation_Points
  - DataSources
  - DMU
  - Glossary
  - Methods

Subsurface mapping using IsoValueLines has a workflow similar to creating a normal GeMS geologic map:

- Add subsurface-specific attributes and create nonspatial tables

- Use geologic data to create GeMS-required ContactsAndFaults and MapUnitPolys feature classes

- Validate GDB through both the GeMS validation tool and the GeoLex geologic names tool