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3-D Geological Model of the South End of the Beaverhead Mountains, Eastern Idaho, Based Solely on Geologic Map Data

earthVision by DYNAMIC GRAPHICS, INC.
www.dgi.com

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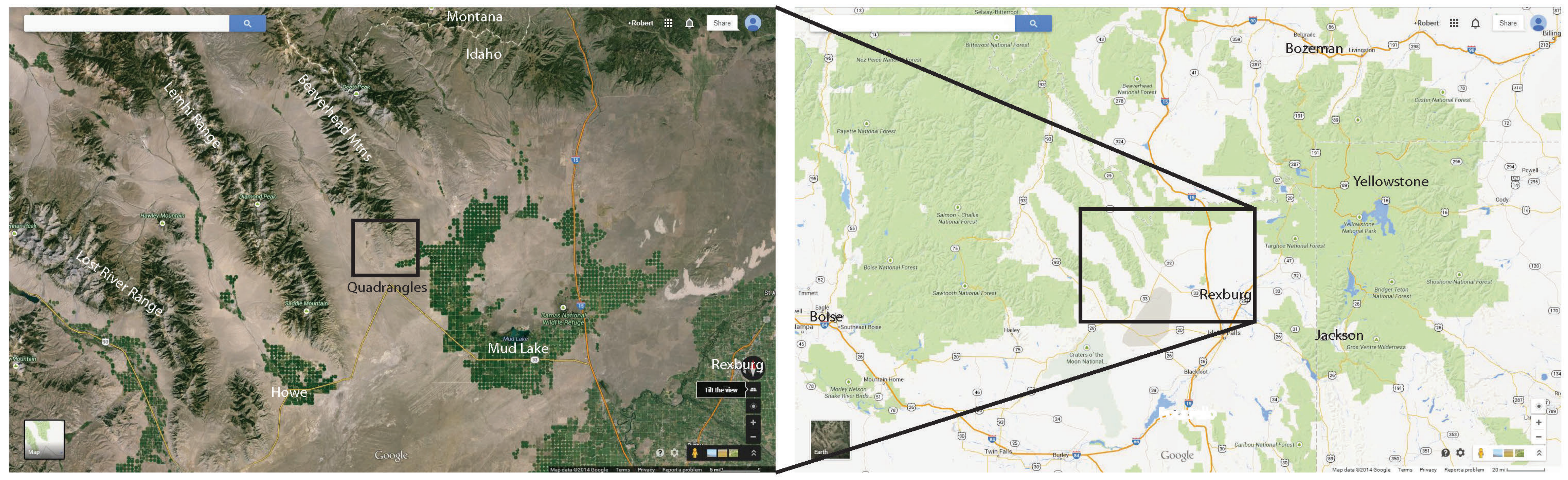
Summary

This poster presents a three-dimensional geological model of the Scott Butte and Snaky Canyon 7.5-minute quadrangles, created using earthVision software. Most 3-D models are created using subsurface data, but this model was created solely using geologic map data created by the BYU-Idaho Field Camp program. Creating a 3-D model forces a geologist to interpret strata and structures to depth like cross-section creation does, but with the added challenge of making the interpretations coherent along strike. I suggest that this makes the modeler a better mapper and a better geologist.

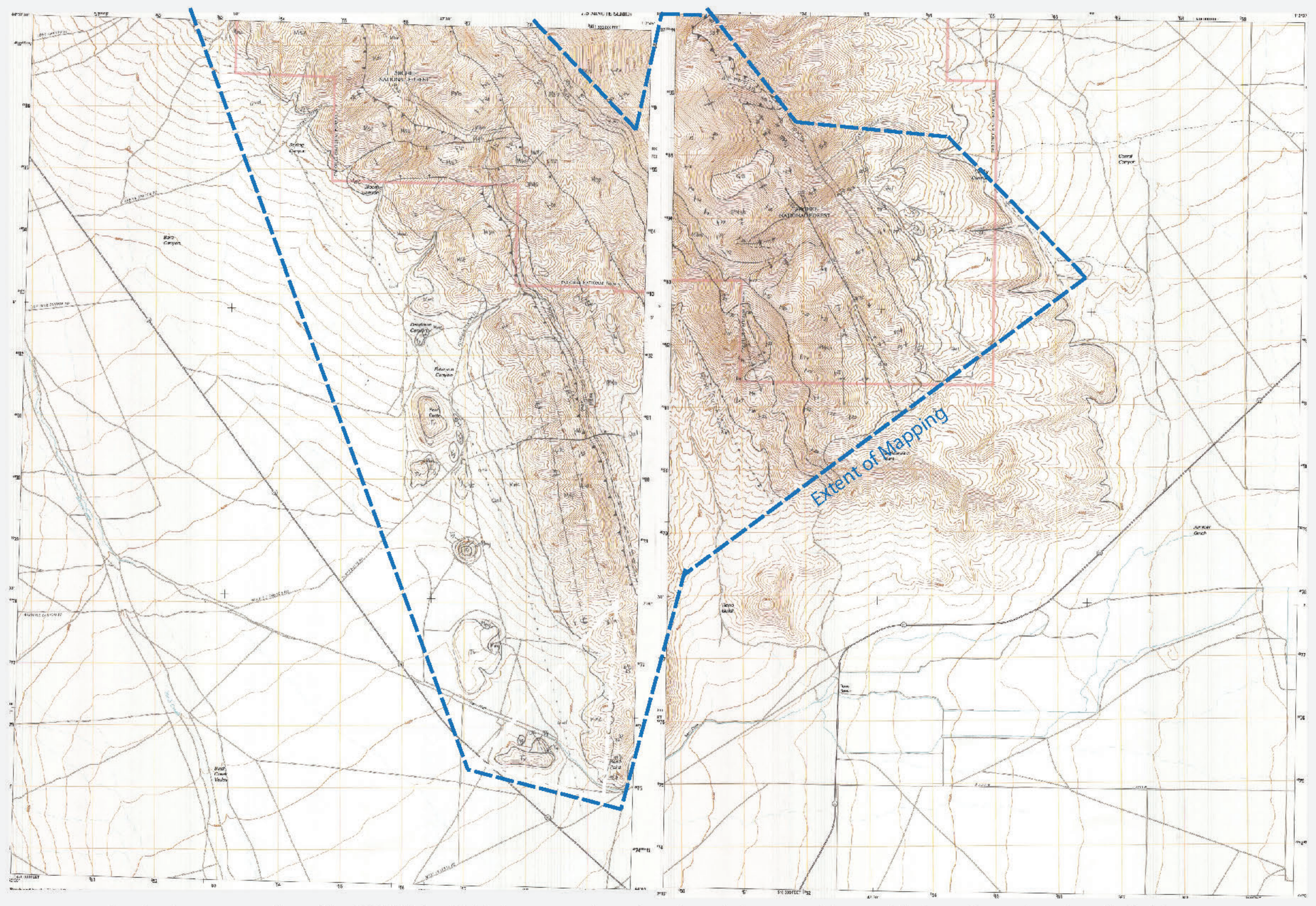
Features of the model and challenges in its creation are discussed in the figure captions below.



Modeling Procedure (all steps were done within earthVision software)

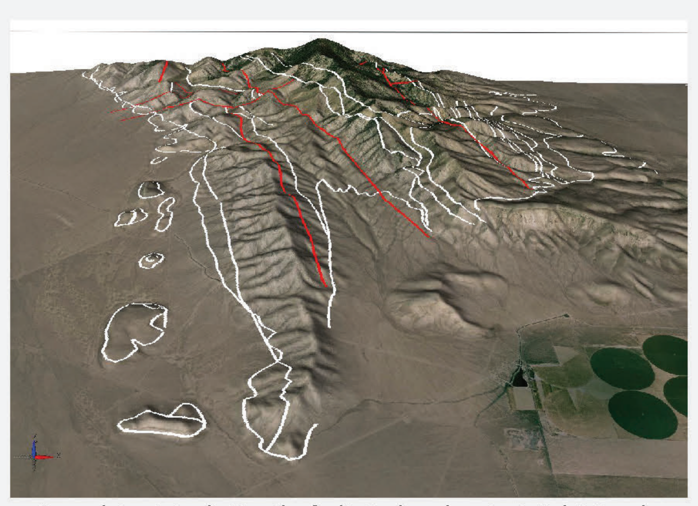
1. Georeference the geologic maps.
2. Digitize contacts, faults, and strike-dip data.
3. Drape the digitized data onto the topography to calculate z (elevation) values.
4. Create fault surfaces
   a. Project map data upward and downward using geometric equations
   b. Create a 2-D grid of the surface
5. Create reference horizons
   a. Select based on abundance of data
   b. Project map data upward and downward using geometric equations
   c. Create overturned units using 3-D gridding
6. Create thickness grids for each rock unit
7. Create the unconformity at base of Quaternary units
   a. Remove topographic data that lie on Q
   b. Replace with contours approximating base of Q
8. Create the pre-volcanic unconformity
   a. Remove topographic data that lie on Tv
   b. Replace with contours approximating base of Tv
9. Define the "fault tree" – a description of which faults cut which
10. Define stratigraphic relationships, including "depositional" versus "unconformity"
11. EarthVision then creates the model by making appropriate truncations

Issues During Modeling Procedure (same numbers as above):
4. Geologic map data allow a wide range of dips on most faults. Iterate to determine what works best (is most geologically reasonable).
5. Choose the horizons (contacts) with best geometric definition. This is where you start to find how accurate your map data are! It took much iteration to get dips and thicknesses right. Controlling thicknesses of overturned units was extremely challenging, and not entirely satisfactory at this large scale.

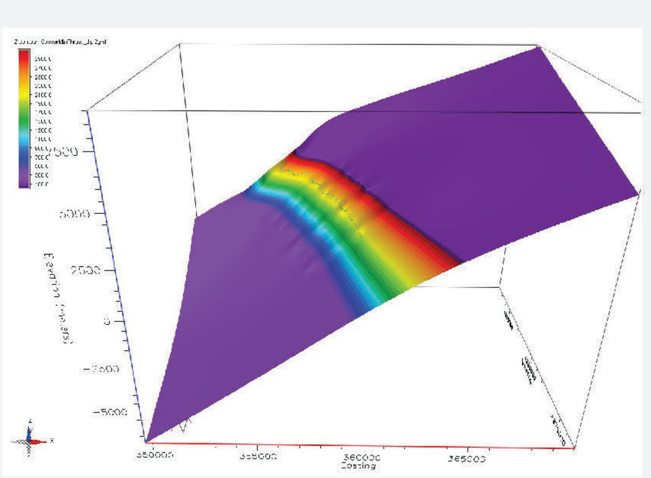


Geologic maps produced by BYU-Idaho Field Camps, and used as the sole input to this model. Scott Butte Quadrangle (left), Snaky Canyon Quadrangle (right). This area is a section of the Sevier thrust belt that has been uplifted in a Neogene Basin and Range horst. Strata are primarily a several kilometers-thick Mississippian to Permian carbonate section. Thrust faults trend N to NNW, while normal faults trend W to NW.

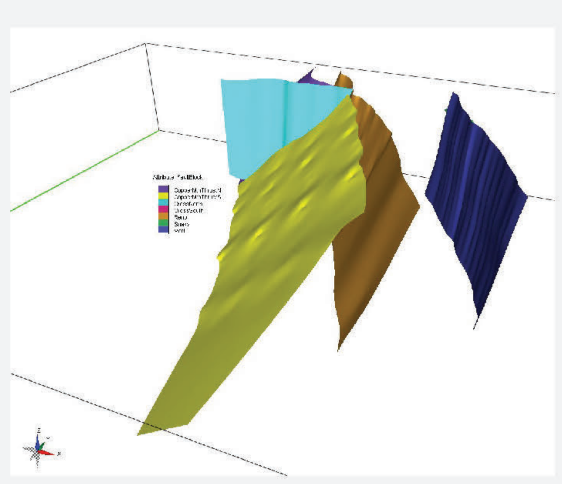
First step is to georegister the geologic maps, shown here draped on the topography in earthVision software.



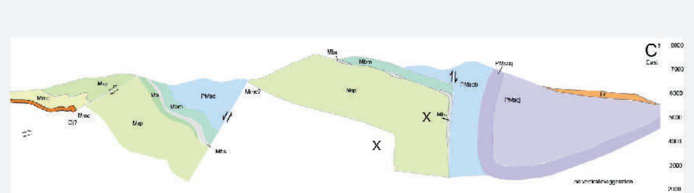
Second step is to digitize the faults (red) and contacts (white) and give them z values by back-interpolating on the topography.



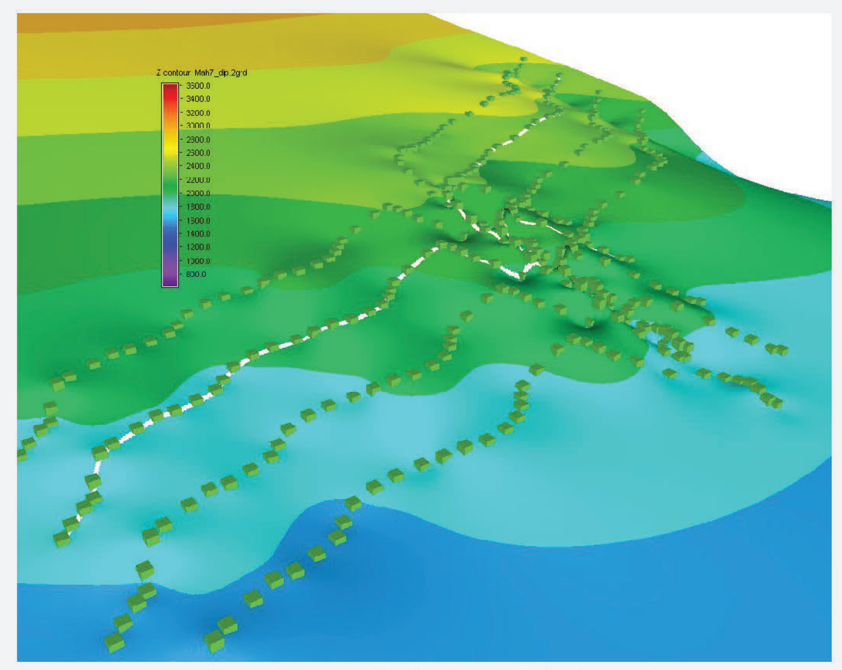
The first surfaces to create are the fault planes. The surface shown here is the Copper Mountain thrust fault. Data (squares) were extrapolated upward and downward using geometric equations. The vertical model extent is shown as the contoured interval; the rest is ignored in model creation.



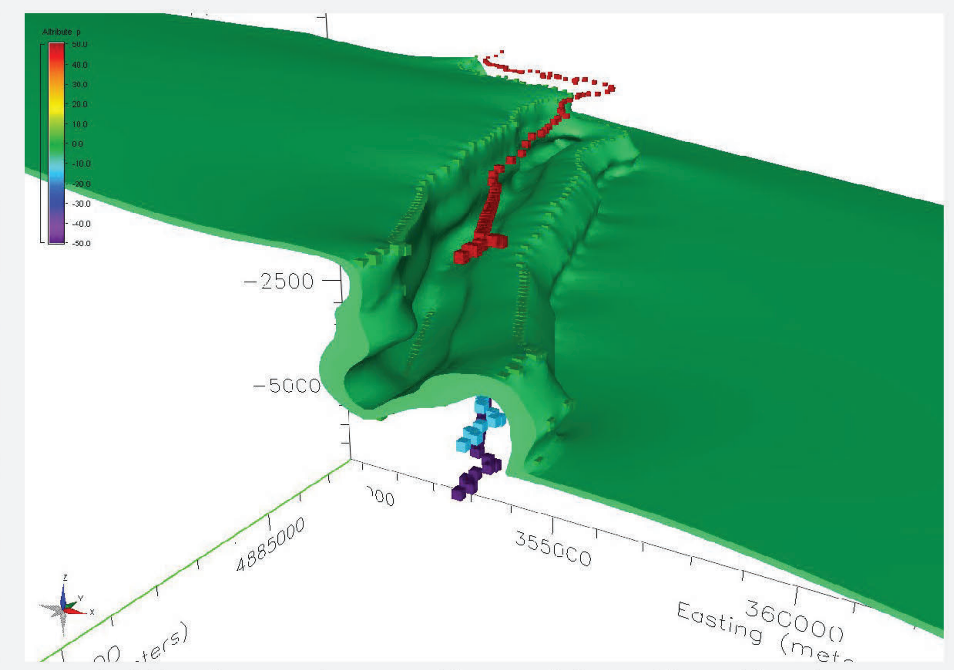
This view shows all the fault surfaces, looking NNW. EarthVision software truncates faults based on user-defined relations.



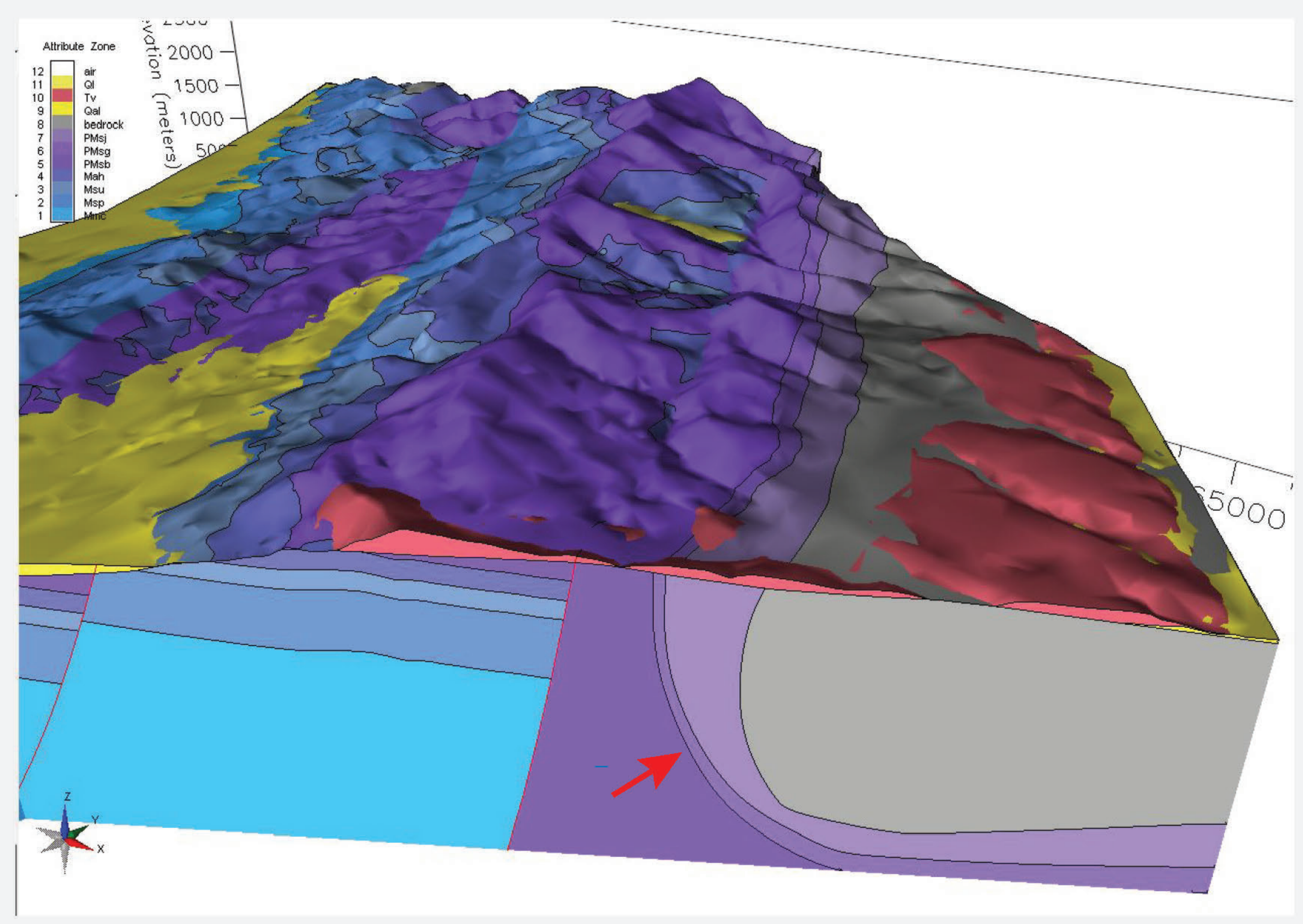
The conceptual model at left was used to guide construction of the model. Some features of the conceptual model were changed to be consistent in 3-D, including dip of the units west of the eastern fault.



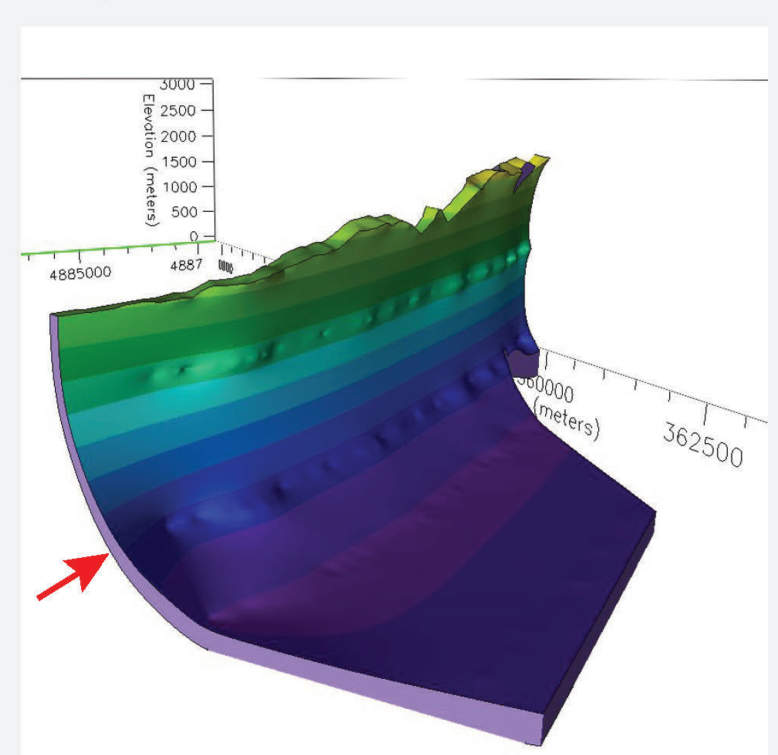
The top contacts of formations are called horizons. Geologic map data were extrapolated upward and downward using geometric equations. The map data are shown here with a white line through them; the other points are extrapolated. 200m contour interval, view toward NW. During the modeling process, this surface is truncated by faults as defined by the user. EarthVision software also defines surfaces as unconformities and channel fill. In this model, the topography, the base of alluvium, base of volcanics, and base of the landslide were defined as unconformities.

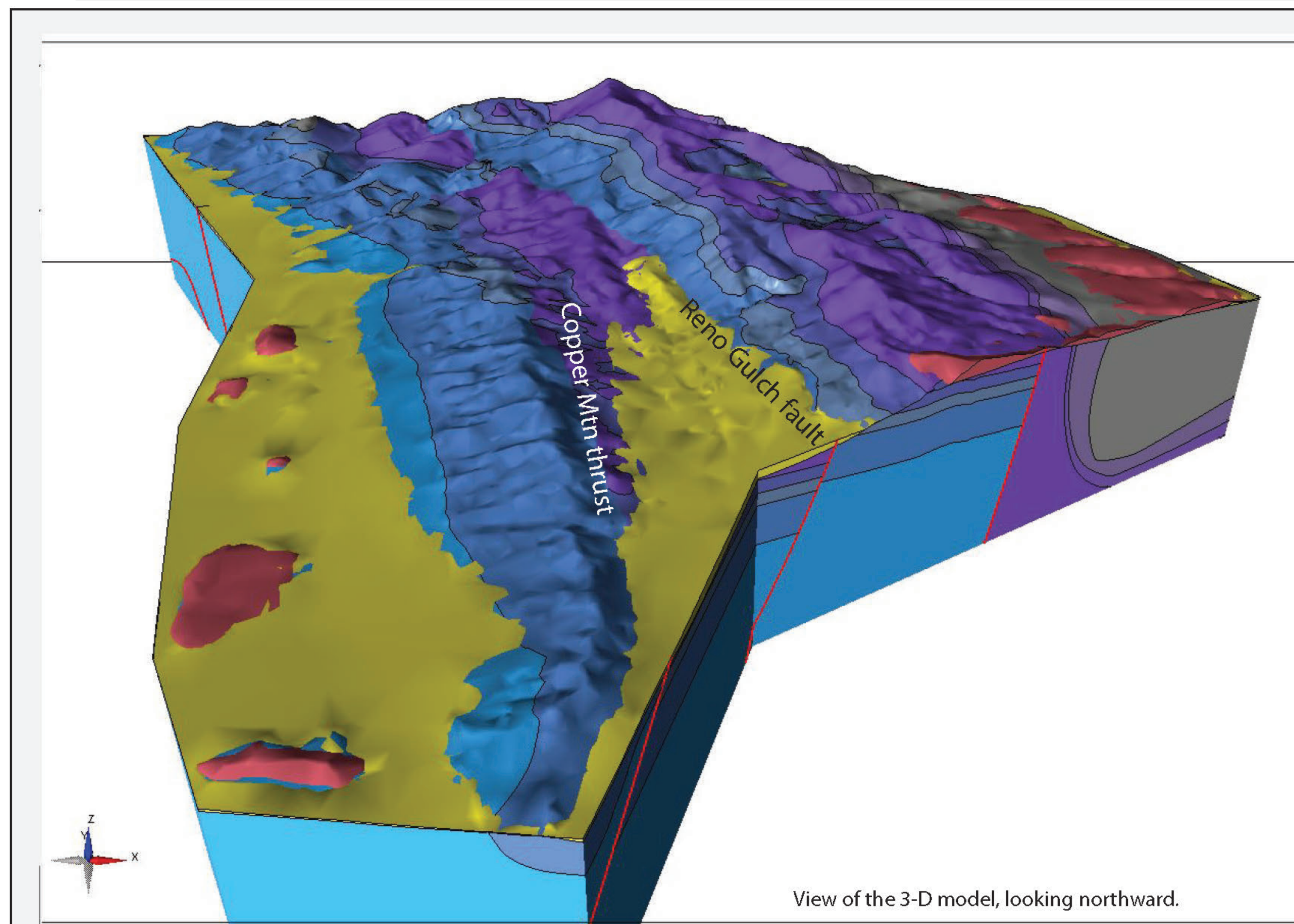


Complex folds and overturned units posed the major challenge of this model. Geologic map data were projected upward and downward using geometric equations and a conceptual cross-section to produce the data points shown here. A property value of 0 was used for contact data, and higher and lower values were used above and below the surface to constrain the 3-D contours. EarthVision uses the 0 contour to represent the overturned contact. The full complexity of folding could not be represented at this scale, nor could fine irregularities be smoothed out. A higher resolution model just of this fold could solve those problems. The flat areas to the left and right were not part of the model.

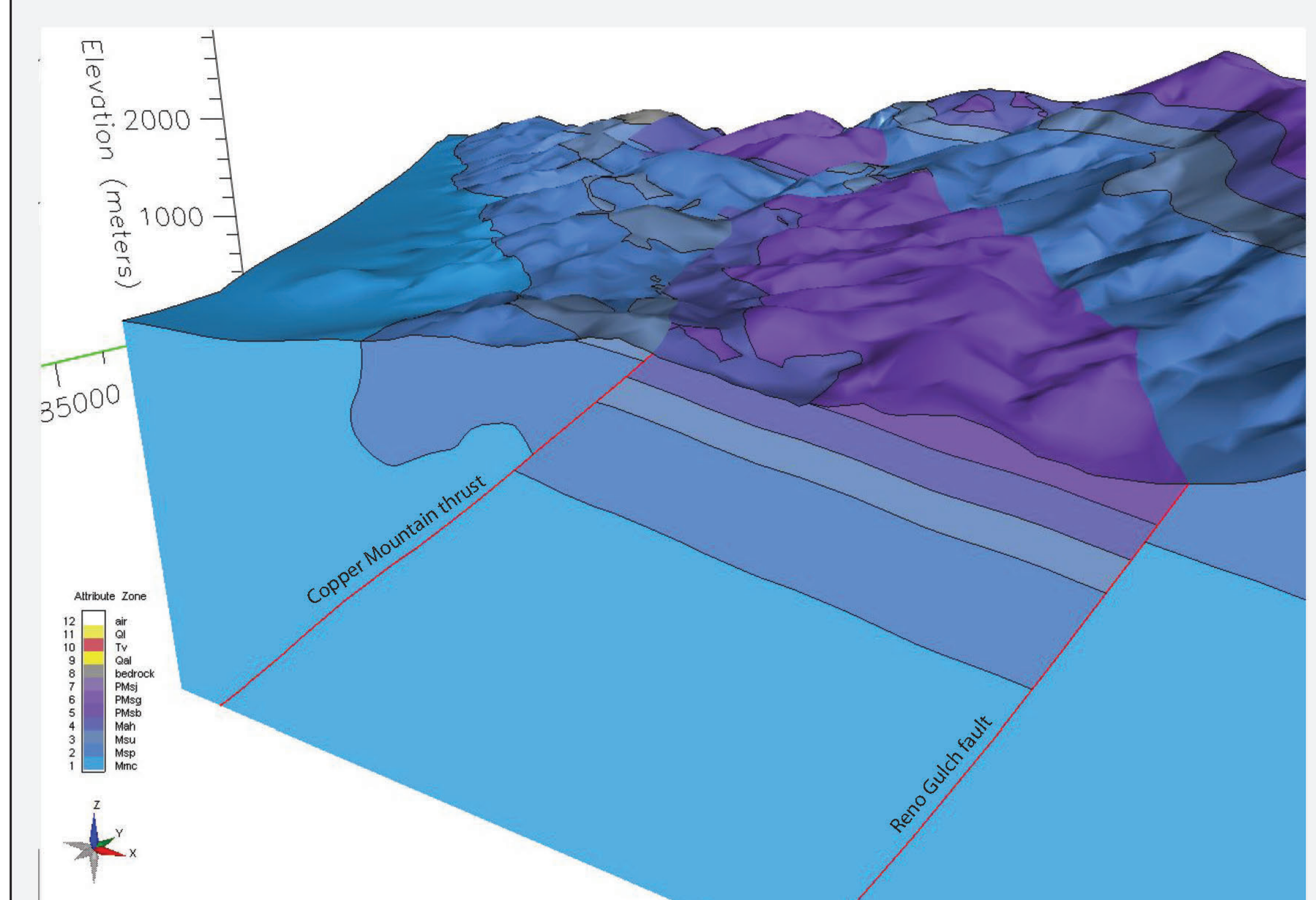


Overturned units on the east side of the model include the Snaky Canyon Formation members (in purples). A limitation of this modeling method is the difficulty in maintaining unit thicknesses in three dimensions. A higher resolution model would be needed to do so. The red arrow points to PMsg, the unit isolated in the view below. Contour interval below is 200m.

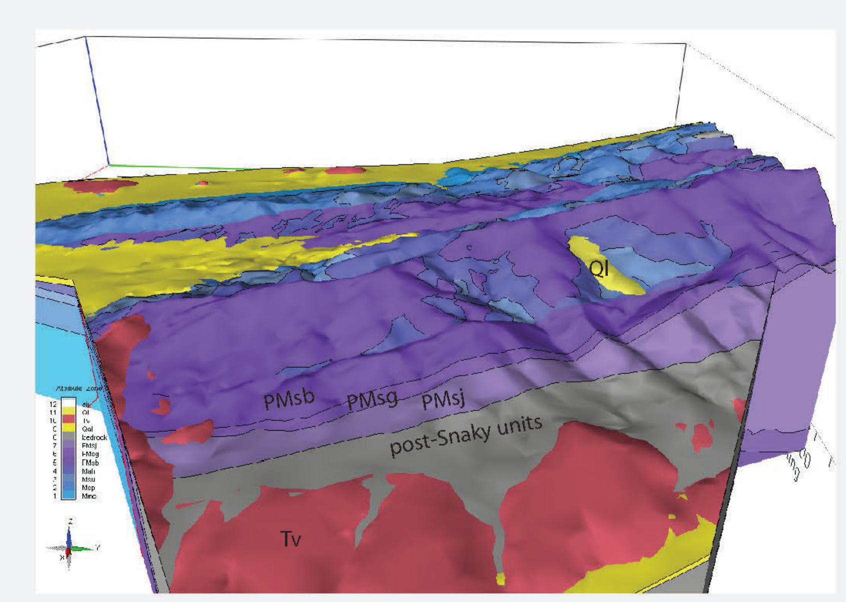




View of the 3-D model, looking northward.



View of the northwestern part of the 3-D model, showing complex folding above the Copper Mountain thrust. Alluvium has been removed for clarity.



View toward the west of the Snaky Canyon formation members (purples) and a large landslide. The landslide was modeled by replacing the topographic unconformity with contours on the base of the landslide. The landslide is its own surface (grid).