

Lindsey German

May 3, 2012

## Determining the Location of the Simav Fault

### 1. Introduction and Problem Formulation:

The issue I will be focusing on involves interpreting the location of the Simav fault in western Turkey. This fault has been mapped to different extents in the literature, and I plan on using ArcGIS to compare the various interpretations. I will be looking at river drainages and offsets, slope, and topography breaks to assist me in determining the location of the fault. Ultimately, I will target potential locations of the fault for future field work.

### 2. Data Collection

- [ASTER GDEM \(Airborne Spaceborne Thermal Emission Reflection Radiometer Global Digital Elevation Model\)](#)

The digital elevation model used was found using the ASTER website. The ASTER data is made available by NASA and METI, and the data exists for 99% of earth's surface. However, only registered members are able to access these models with a 30 meter resolution. The rectangular area I chose to work with spanned an area which included 22, 1 degree by 1 degree tiles (Top latitude: 40 °N, Bottom latitude: 37 ° N; Left longitude: 27 ° E, Right Longitude: 32 ° E). After ordering the data via Dr. Helper (the registered member), I received an email containing the files that I would use to download the DEMs. Each tile was uploaded to a folder which included a DEM file (\_dem), a quality assessment file (\_num), and a readme file. The dem and num data files have dimensions of 3,601 samples by 3,601 lines, corresponding to the 1 x 1 tile

area. The data was already Georeferenced to GeoTIFF files, and referenced to the 1984 World Geodetic System (WGS1984), so this made it easy to work with the DEMs in ArcMap.

- Scanned maps from the Geosciences library at the University of Texas at Austin

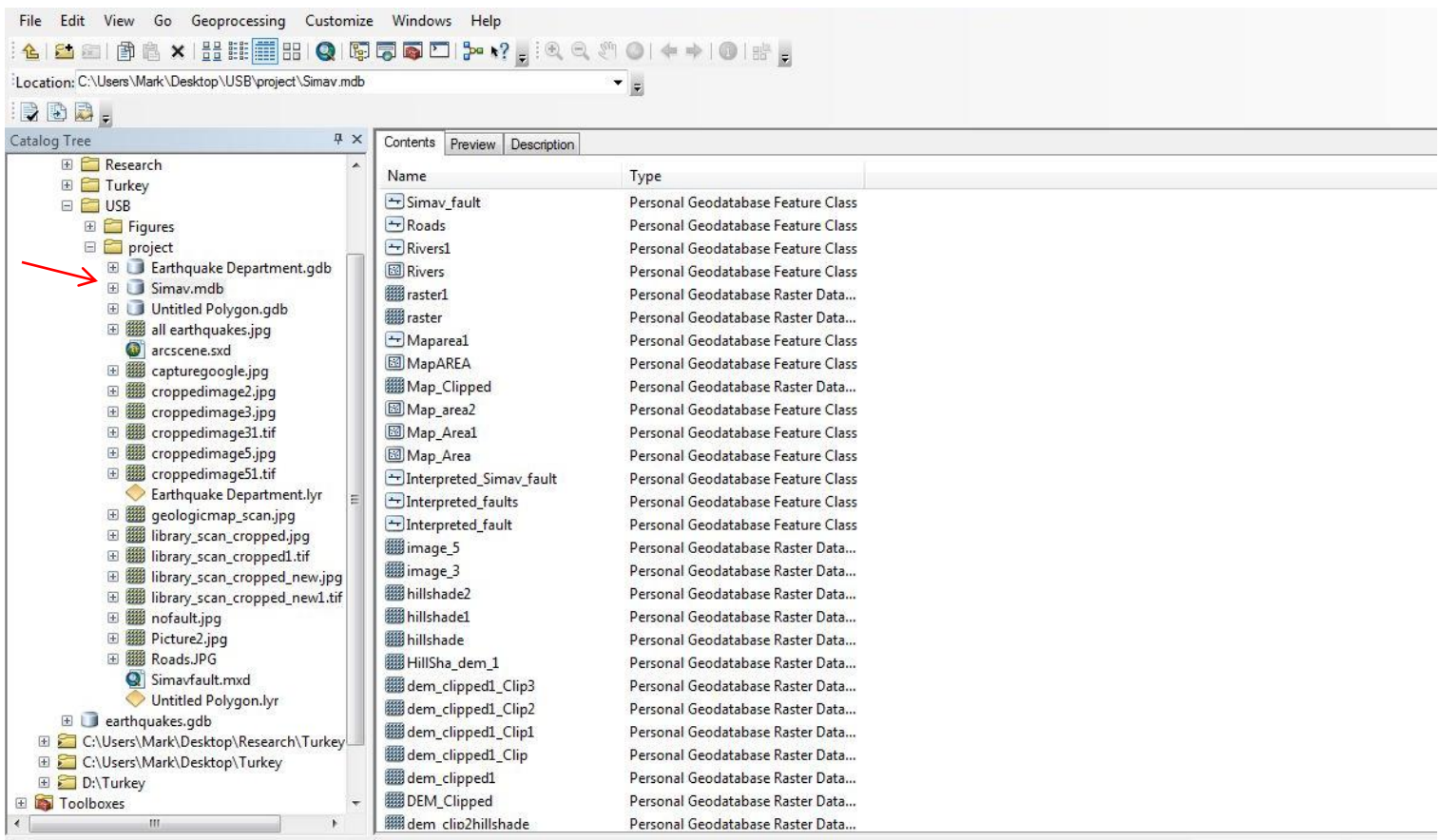
The following maps were used to digitize the location of the Simav fault and to map major cities and rivers.

- a. Geomorphological Map of Turkey
- b. Active Fault Map of Turkey
- c. Geological Map of Turkey

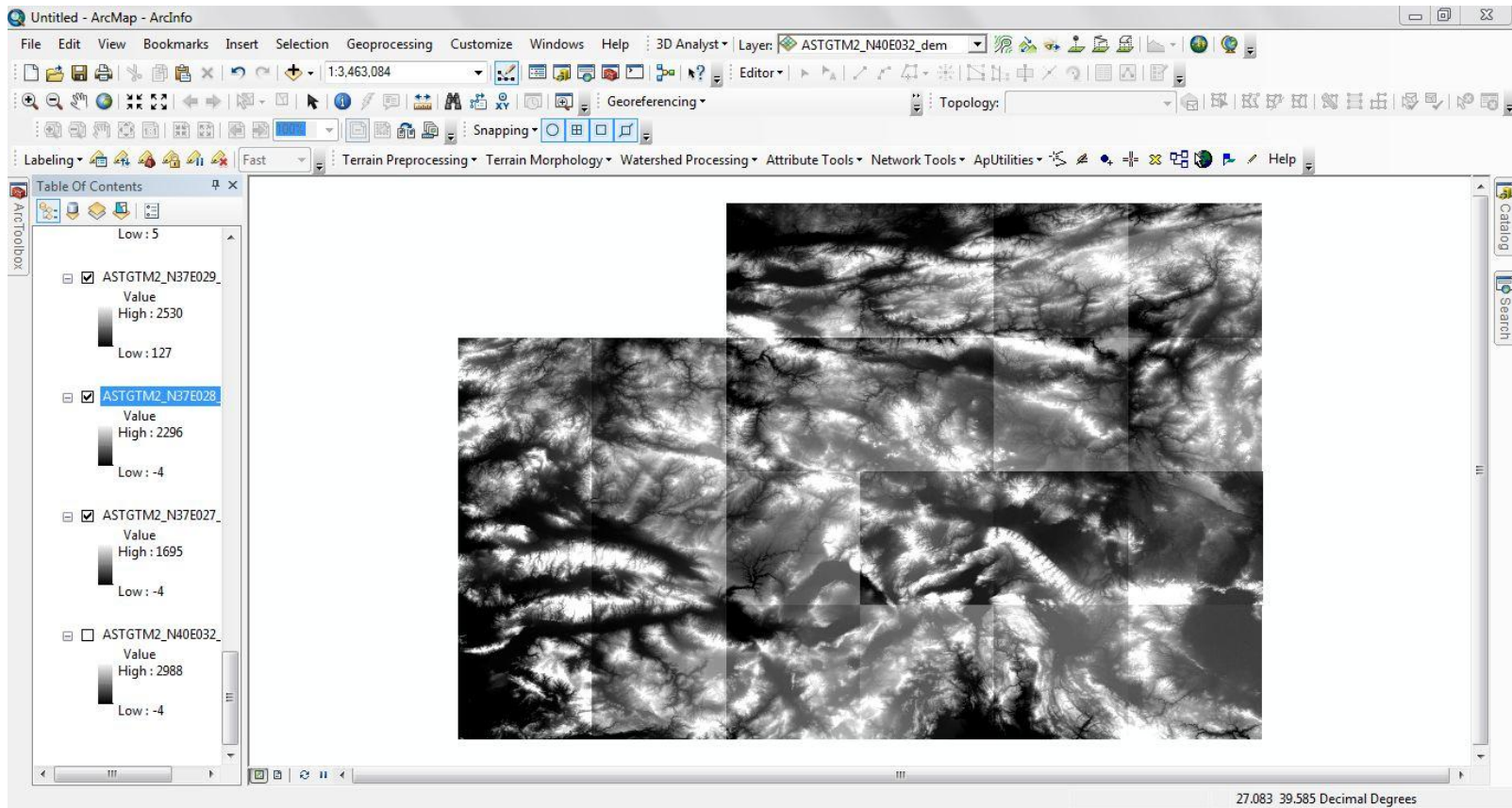
### **3. ArcGIS processing**

One of the most important things to do before processing any data in ArcGIS was to make a Geodatabase to store and organize all of my rasters, shapefiles, and any other data that is necessary to utilize for this project. My Geodatabase is named "Simav," and a screenshot of ArcCatalog is shown in **figure 3.1**. After creating a new map in ArcMap with the default geodatabase set to Simav, I went to the properties for the layers and set the coordinate system to GCS\_WGS1984.

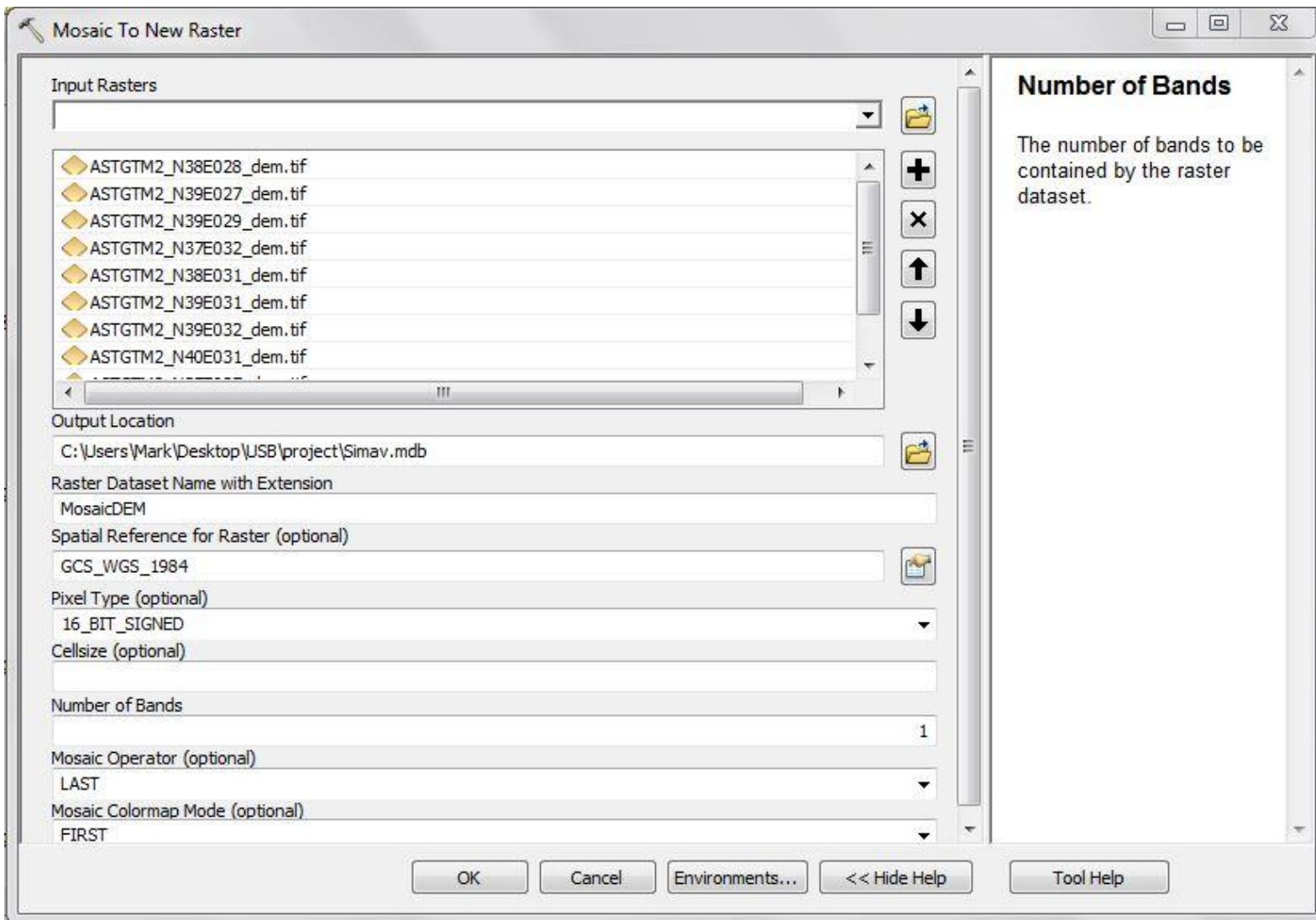
Because the location of the fault is not clearly mapped in the literature, I needed to order 22 ASTER tiles. Using the “Add Data” icon, I uploaded all of my data, then right-clicked each dataset→**properties**→**symbology tab**, and set the stretch type to standard deviations with n=2. The result is seen in **figure 3.2**. In order to analyze the rasters without the lines in between each one, my next step was to create a mosaic using a tool found in the ArcToolbox. I mosaicked all of my rasters to a new raster named ‘MosaicDEM’ (**Figure 3.3**).The result of this process is seen in **Figure 3.4**. Notice the mosaicked DEM is now free of the lines that were once separating each tile.



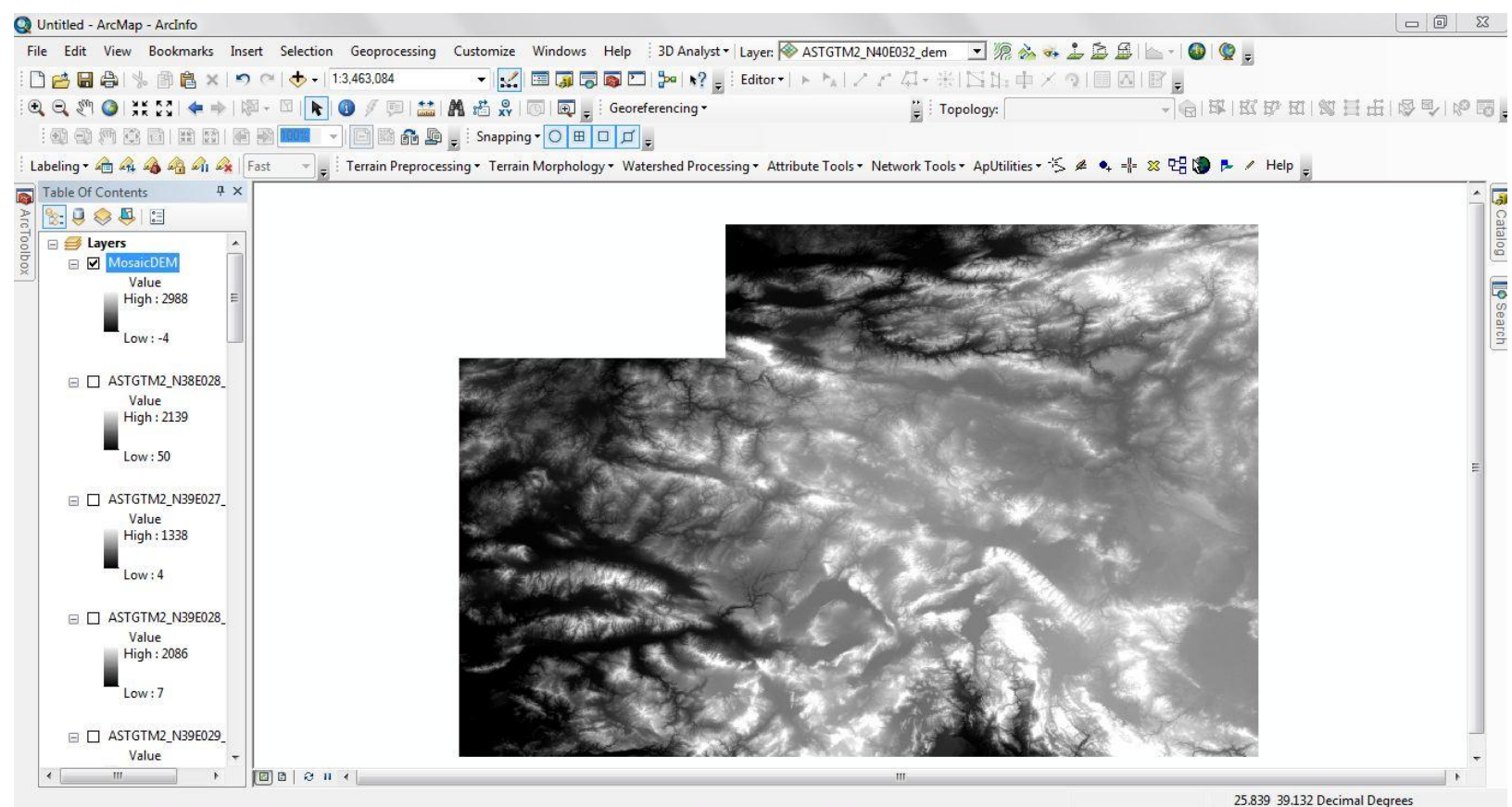
**Figure 3.1:** Screenshot of ArcCatalog showing the Simav Geodatabase



**Figure 3.2.** All rasters loaded into ArcMap; notice the lines in-between the rasters.

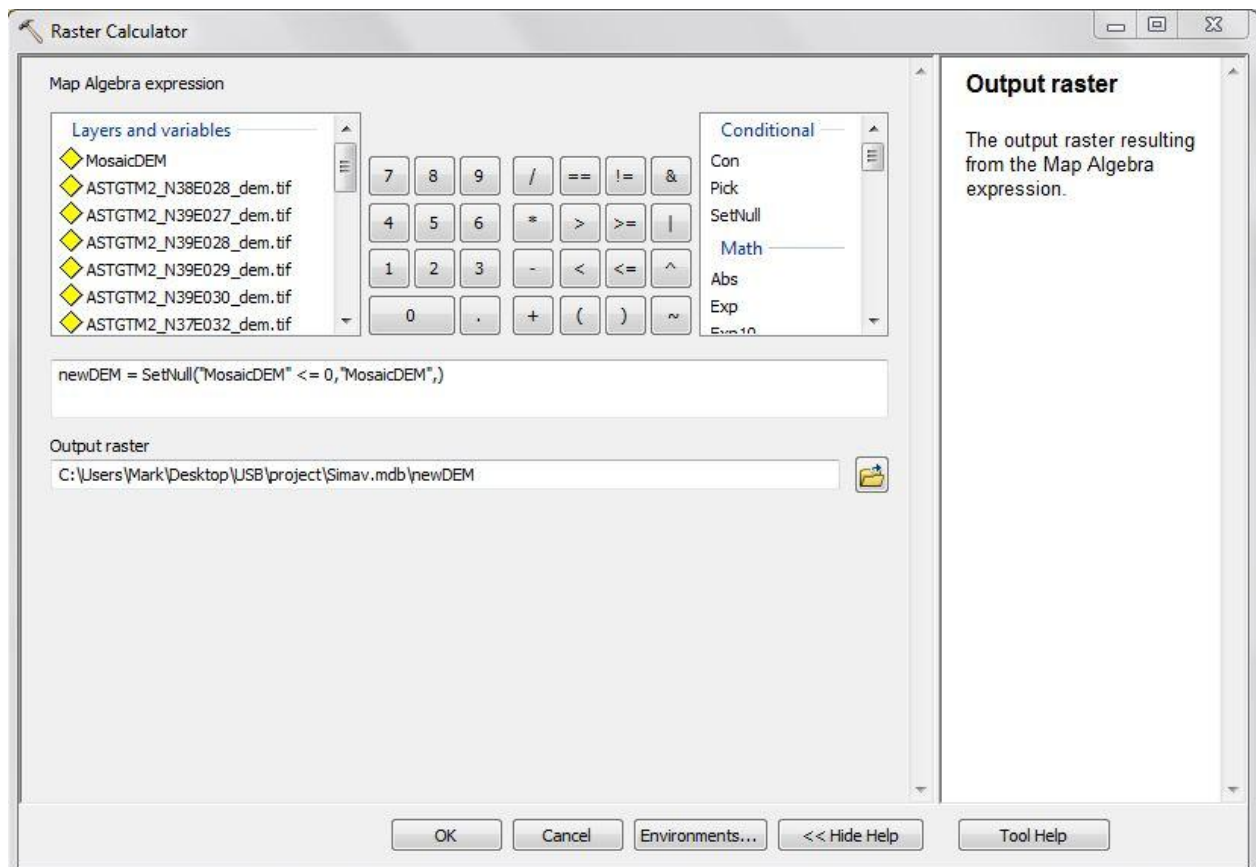


**Figure 3.3.** Screenshot created in ArcMap, Mosaic tool found in the **ArcToolbox**→ **Data Management**→**Raster**→**Raster Dataset**→**Mosaic To New Raster**.



**Figure 3.4.** Result of creating a single mosaic of the rasters.

The mosaicked raster ranges from -4 to 2988 meters, but I want to set the negative values to “nodata.” To do this, I need to create another raster to set the negative cell values to cells displaying “no data.” This will be done by creating an algebra expression using the **Arctoolbox→Spatial Analyst Tools→Map Algebra→Raster Calculator (Figure 3.5)**. The DEM is now named “newDEM”.



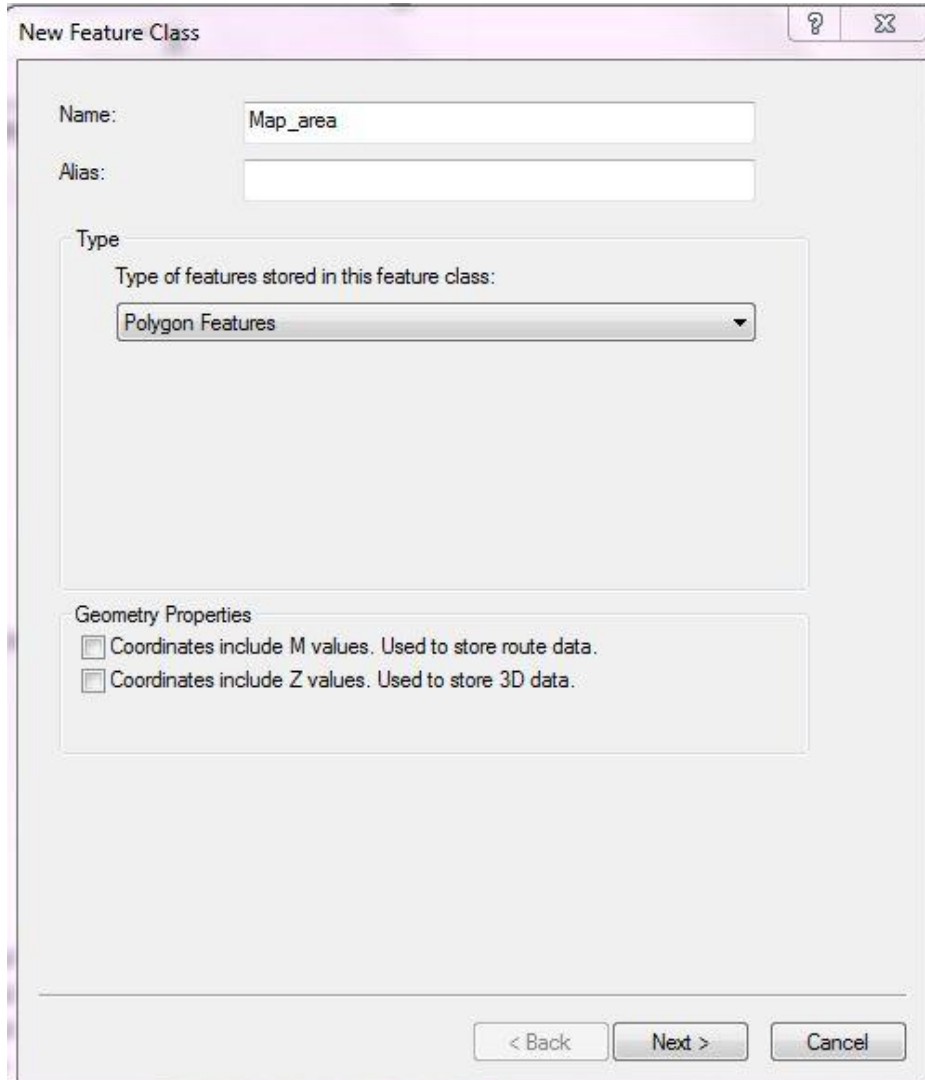
**Figure 3.5.** Raster Calculator tool setting all values less than or equal to 0 to cells displaying “nodata.”

### *Clipping*

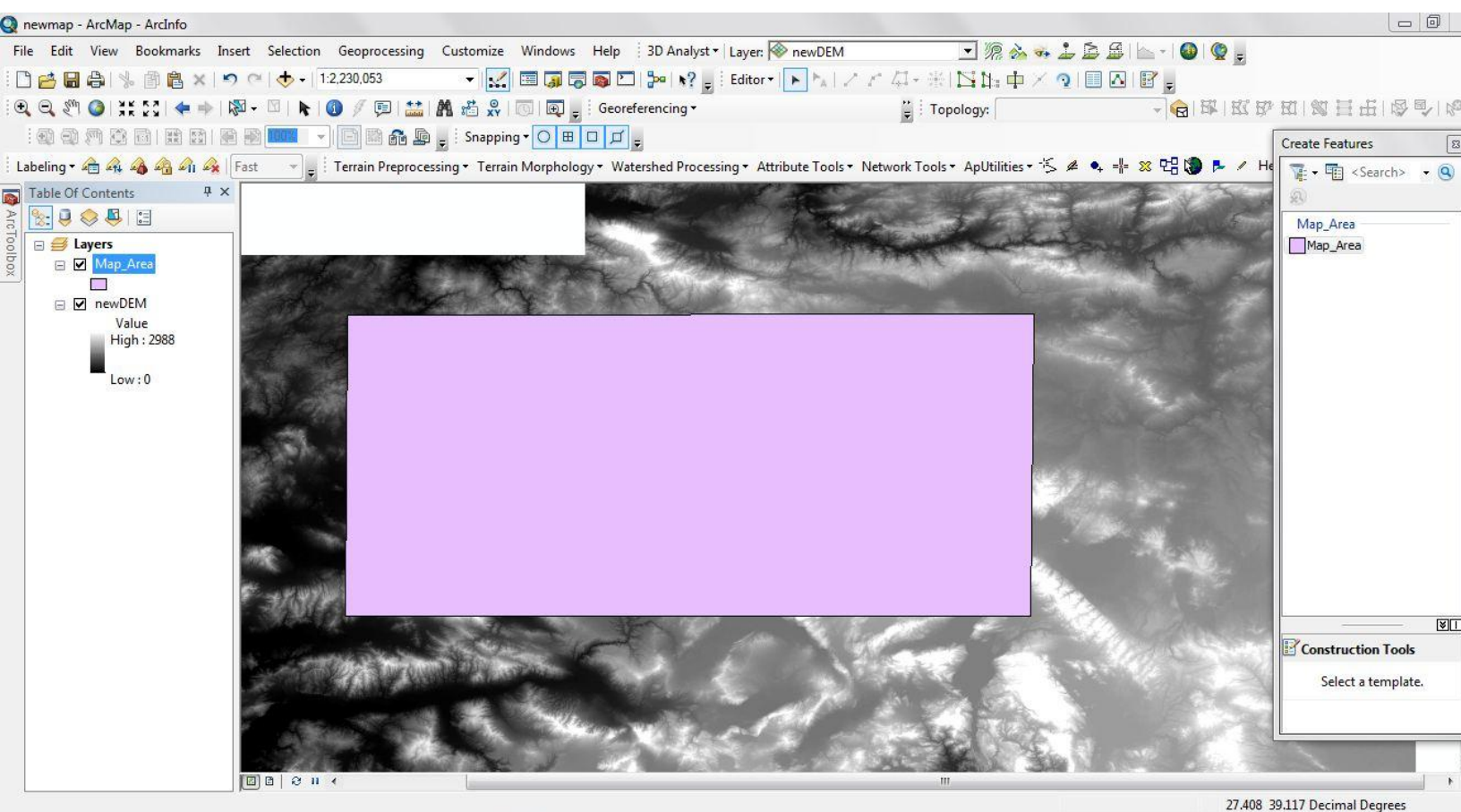
The next step was to analyze the area where the fault may exist, but the newDEM covered an area that was much larger than the area I was concerned with. To create a new raster which encompassed a smaller area, I needed to start the clipping process. This was done by creating a polygon surrounding only the area that I was interested in; the polygon would serve as the layer that I would clip my mosaicked raster to. This feature was created in ArcCatalog by right-clicking the “**Simav**” **Geodatabase** → **New** → **Feature Class** (**Figure 3.6**). I named the new feature “Map\_area,” and chose the feature class to store Polygon Features. After adding the new feature class “Map\_area” to ArcMap, I turned on the Editor Toolbar, and created a polygon which would bind the area I was interested in clipping to (**Figure 3.7**). I then clipped the



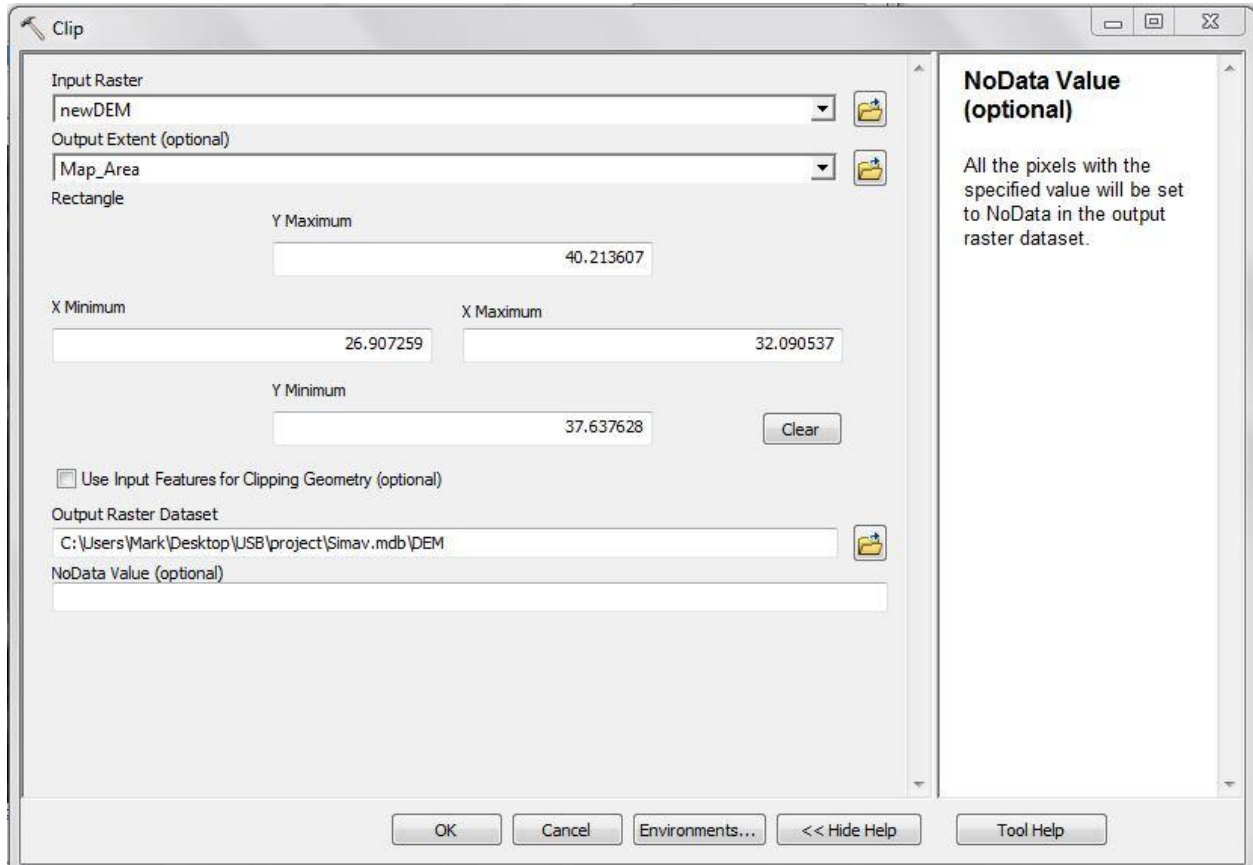
newDEM to the Map\_area, and gave the final DEM the title 'DEM' for simplicity (**Figure 3.8**).



**Figure 3.6.** Screenshot created in ArcCatalog. A New Feature Class is created in the Simav Geodatabase for the purpose of creating a polygon to set a boundary to the area of interest which will be used to clip existing rasters to.



**Figure 3.7.** Map\_area polygon used for clipping. The only area that I wish to analyze lies inside the purple polygon.

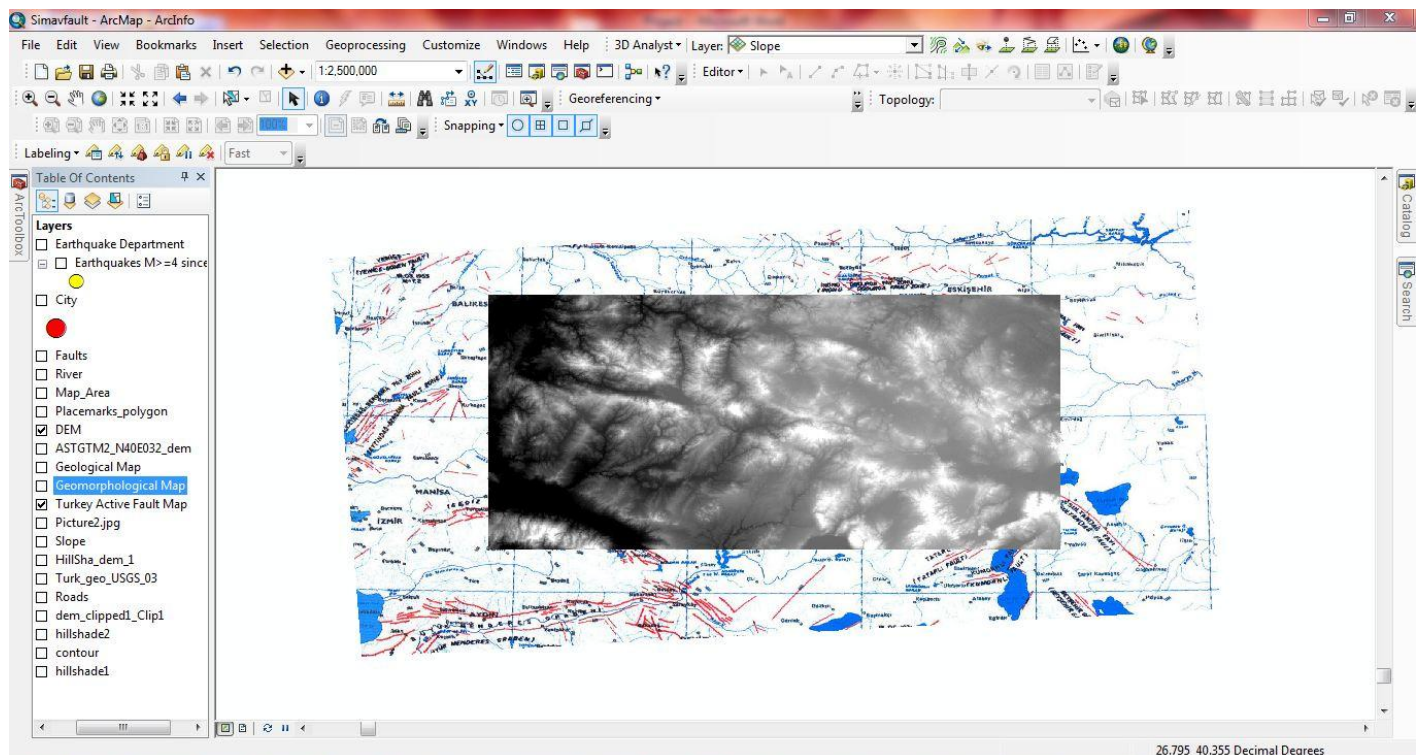


**Figure 3.8. ArcToolbox→Data Management Tools→Raster→Raster Processing→Clip.** This allowed me to clip the newDEM to the Map\_area polygon.

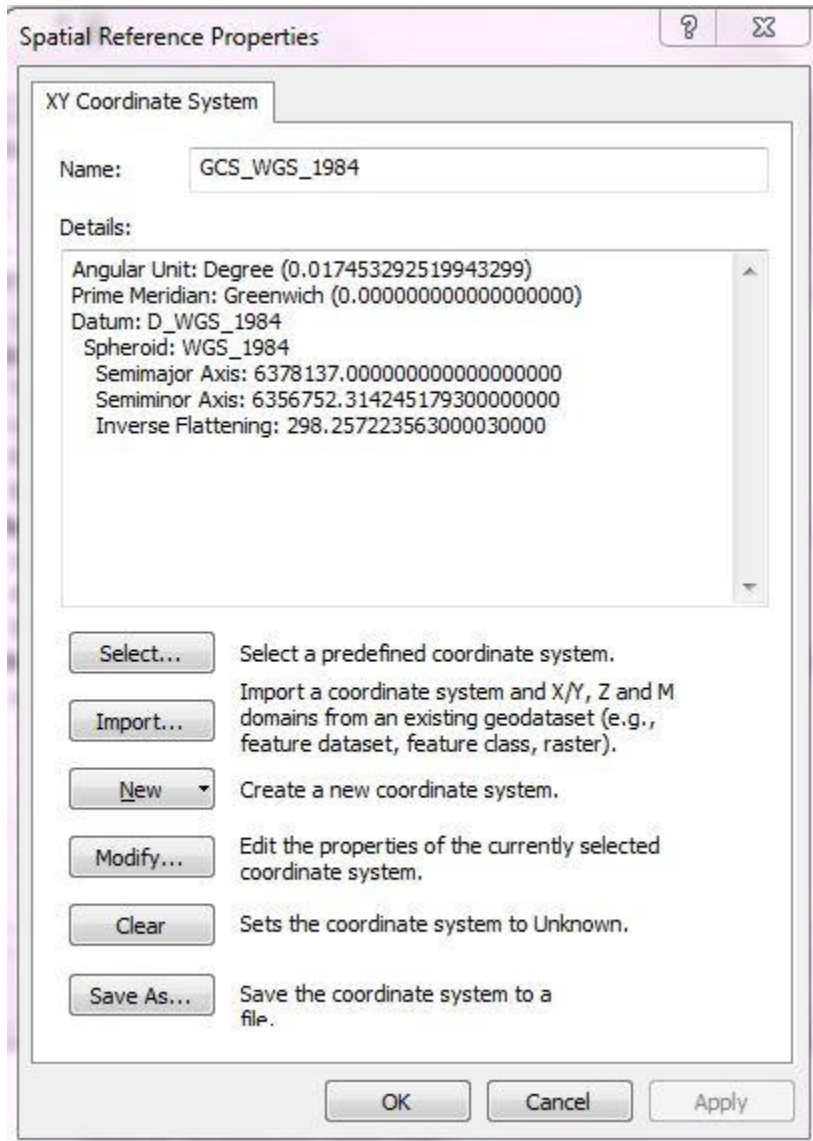
### *Georeferencing*

My next step was to find different interpretations of the Simav fault's length from various maps. The first interpretation of the fault that I analyzed was found in an Active Fault Map of Turkey that I found in the library. After scanning this map, cropping it, and saving it as a .jpeg, I was ready to upload it into ArcMap. Because the map did not contain spatial reference information, the image was placed far away from the DEM. To fix this, I began the Georeferencing process. I

turned on the Georeferencing toolbar and made sure that the active fault map was the displayed layer. The next thing to do was to right click the DEM and choose 'Zoom To Layer.' Next, using the Georeferencing toolbar, I chose **Georeferencing**→**Fit Map to Display**. I then chose to “add control points,” and matched the intersections of the latitude and longitude lines of the active fault map with the corresponding location of the chosen points on the DEM. After using 7 control points in all with an RMS error of .00028, I was satisfied with the result (**Figure 3.9**). The final step was to save the link table, and choose “Rectify” from the Georeferencing dropdown menu. The image has now been saved with geographically meaningful coordinates, but it is still necessary to check that the spatial reference is defined, and if not, set it to the spatial reference of the data frame (GCS\_WGS\_1984) (**Figure 3.10**).



**Figure 3.9.** Result after Georeferencing the Active Fault Map of Turkey with the DEM on top.

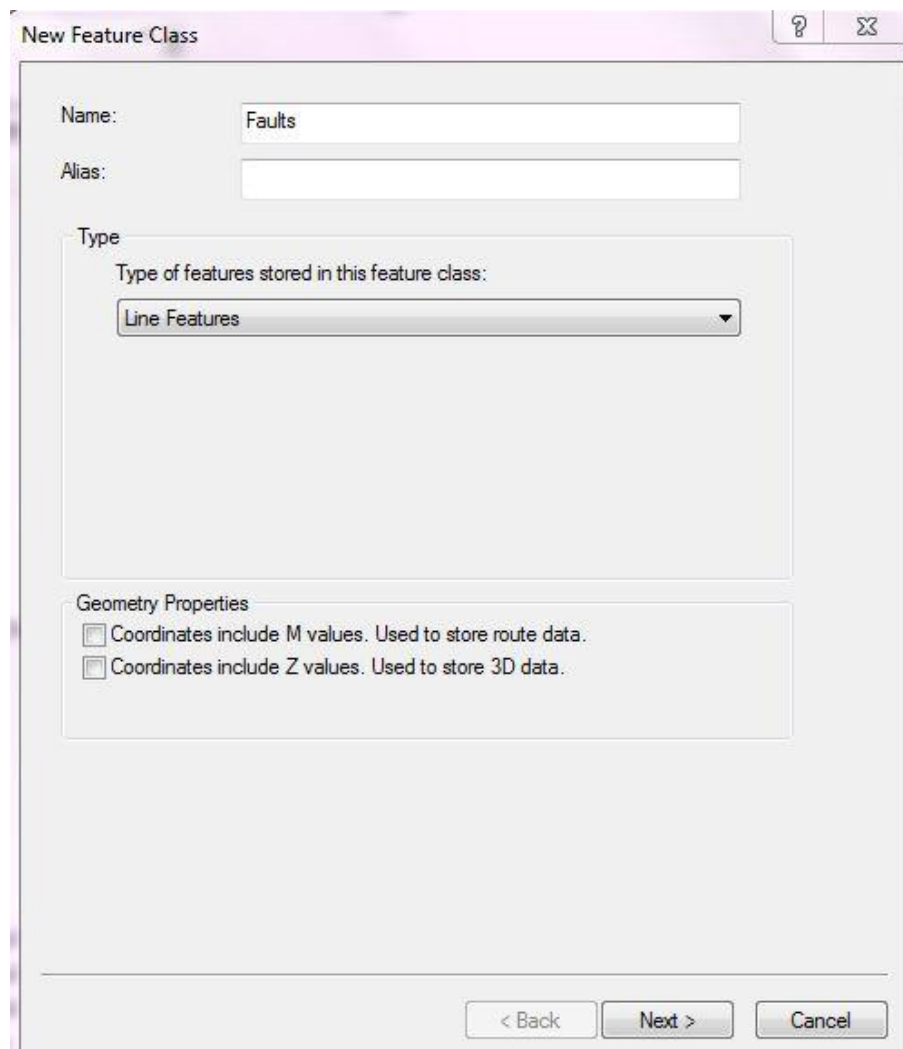


**Figure 3.10.** Setting the reference frame in ArcCatalog. This is a very important step; all layers must be set to the same reference scale. For my project, all layers will be set to GCS\_WGS\_1984.

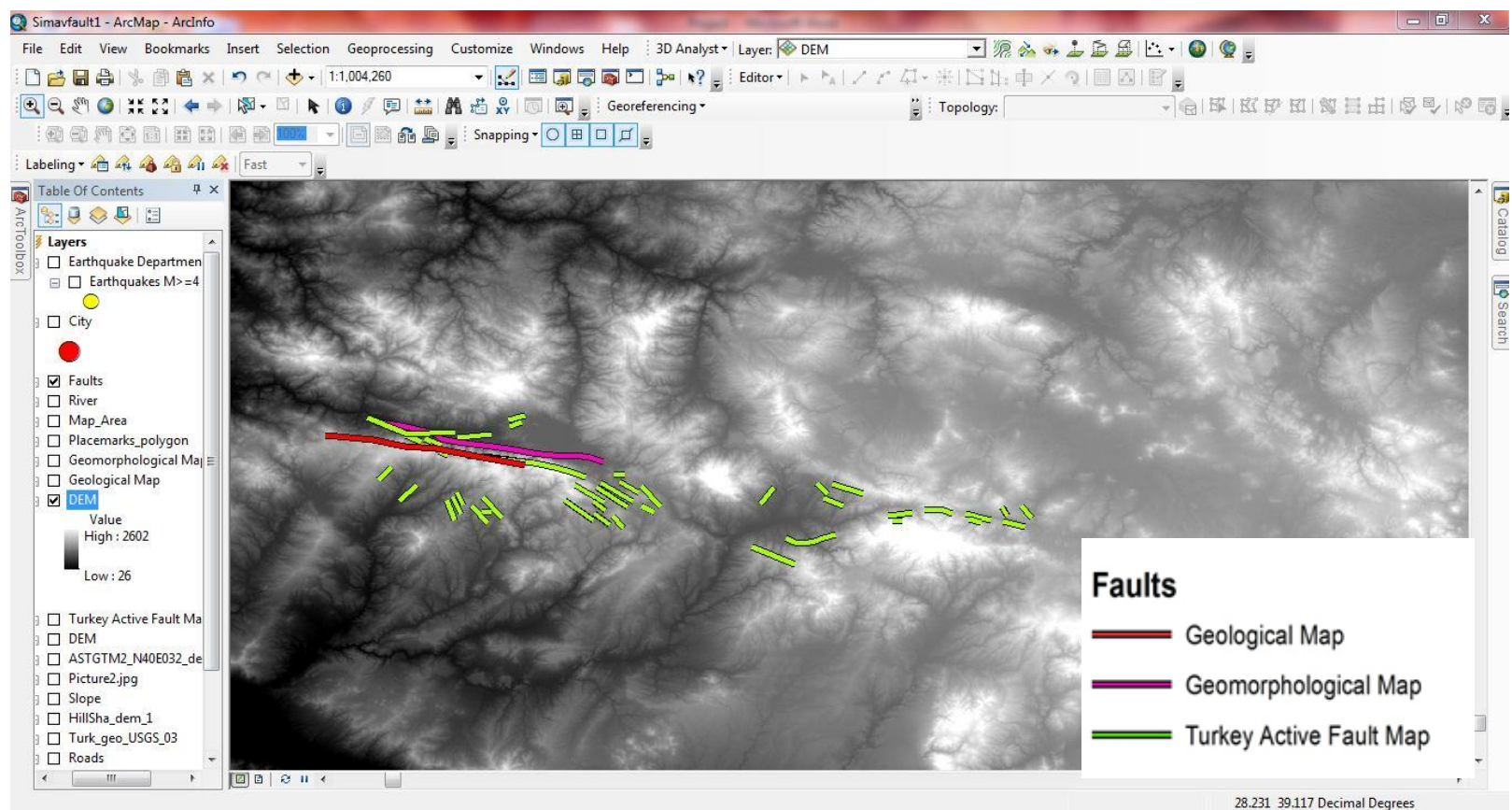
I proceeded to Georeference two other maps (Geological map and Geomorphological Map of Turkey) for the purpose of analyzing their interpretation of the Simav fault's location. The spatial reference of these maps was also set to GCS\_WGS\_1984.

## Digitizing

The next step was to digitize the Simav fault. Using the same process used for creating the Map\_area polygon, I created a new feature class, but this time I'm going to store Line Features to represent faults rather than polygon features (**figure 3.11**). This feature class was used to digitize lines for the location of the Simav fault's extent found in each map (**Figure 3.12**).

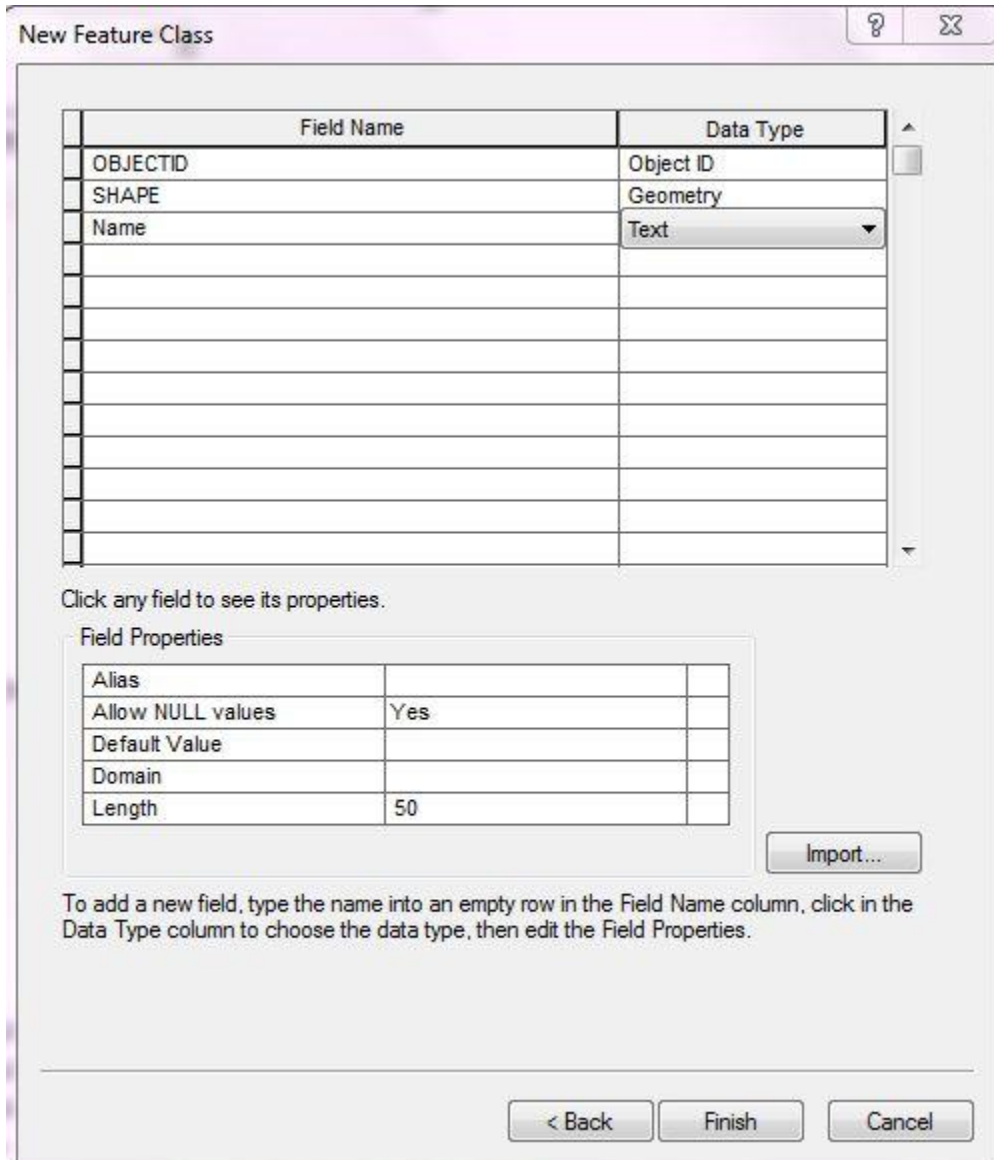


**Figure 3.11.** A new Feature Class is created in the Simav Geodatabase which will be used to store line features to represent faults.



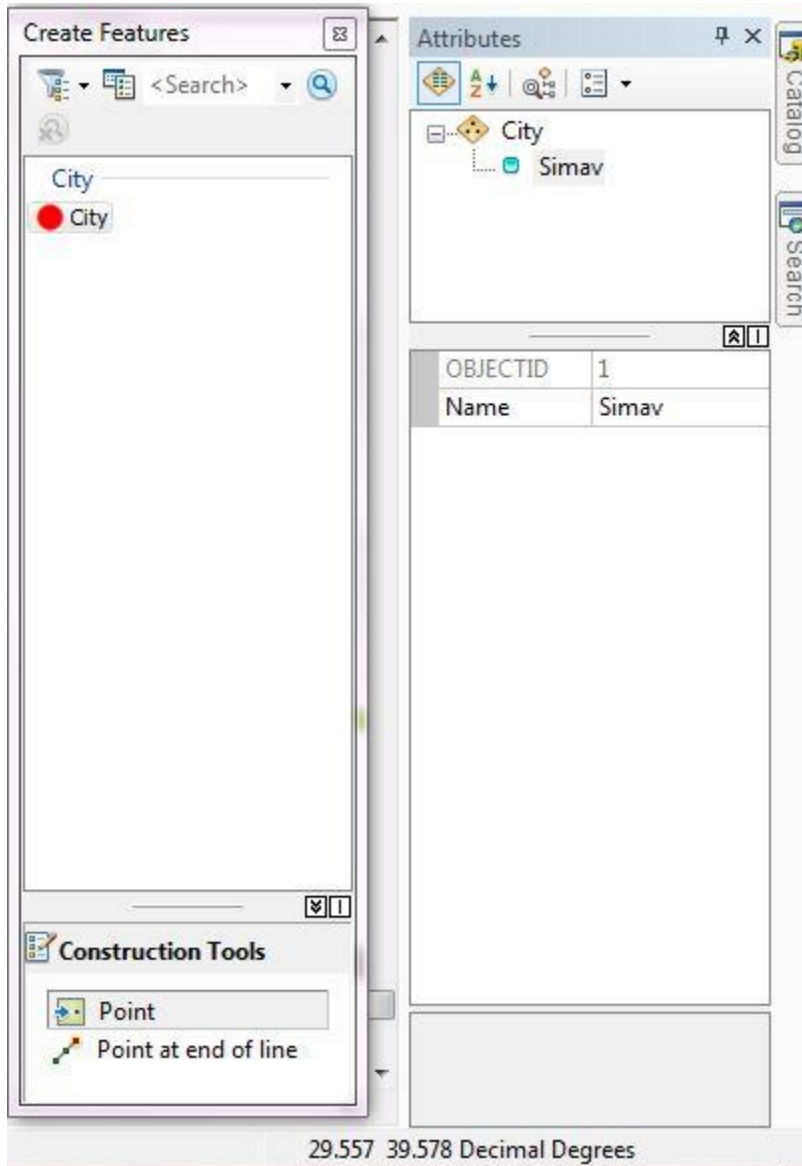
**Figure 3.12.** Using the Editor Toolbar, I created line features representing the different interpretations of the Simav Fault. Each color corresponds to a different interpretation of the fault. The mapped faults seem to cluster in an area defined by a topographic break, and all seem to provide a unique interpretation of the fault’s extent.

To compare the location of the faults to the surrounding cities, I created another new feature class in ArcCatalog just as I did when I created a feature class for the Map\_area and for the faults. However, I will be using point features this time to represent cities, rather than polygon features. After clicking next until I arrived at the field name boxes, I created a new “Name” field with a Data type of “text” (**Figure 3.13**). This field will be used to store the labels of the different cities in the Simav region. **Figure 3.14** shows the process of creating point features for the City layer and storing attributes for each city using the Name field. After creating all the points and corresponding labels, I saved my edits and chose to stop editing. The next step was to right click the City layer and choose “label features.” The result of this process is seen in **Figure 3.15**.

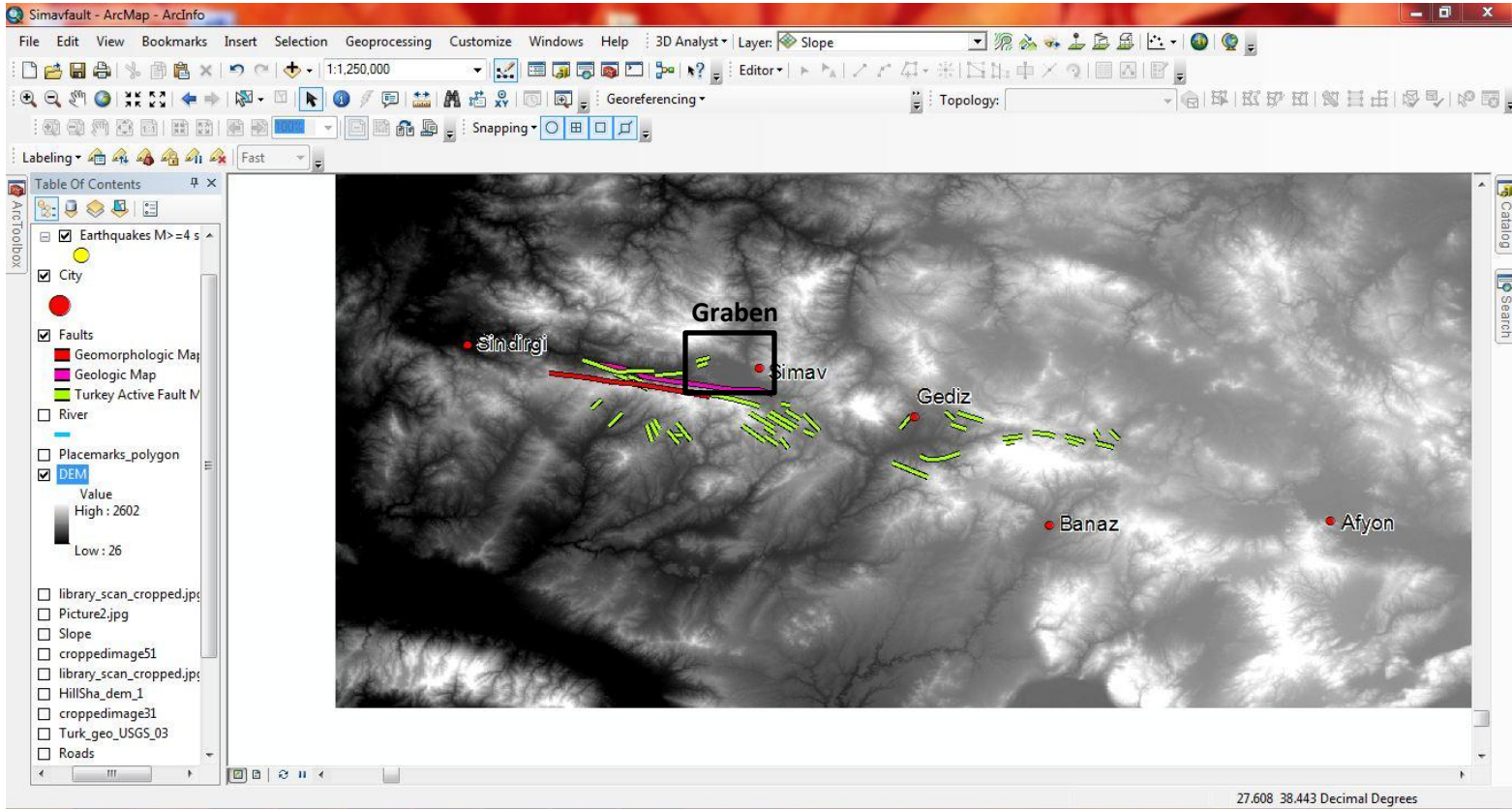


**Figure 3.13.** Creating a new field in ArcCatalog for the purpose of storing the names of the cities in the region.



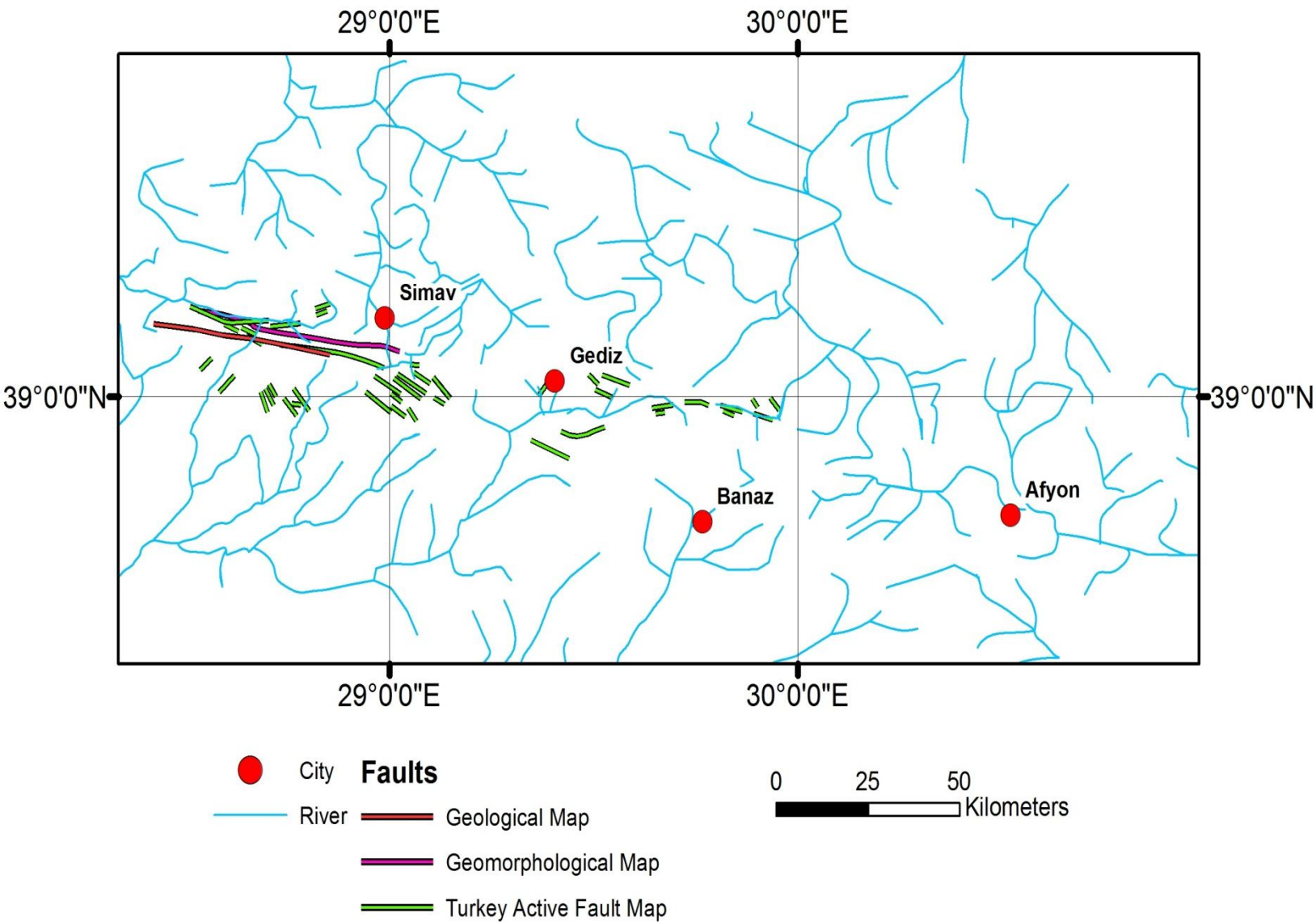


**Figure 3.14.** The City layer is selected as the editable feature, and on the right you can see where I stored the name “Simav” in the attribute table.



**Figure 3.15.** Result of creating the point features for the cities. The cities are also labeled. A feature of low elevation by the city of Simav has been mapped as a Graben which is a down-dropped feature.

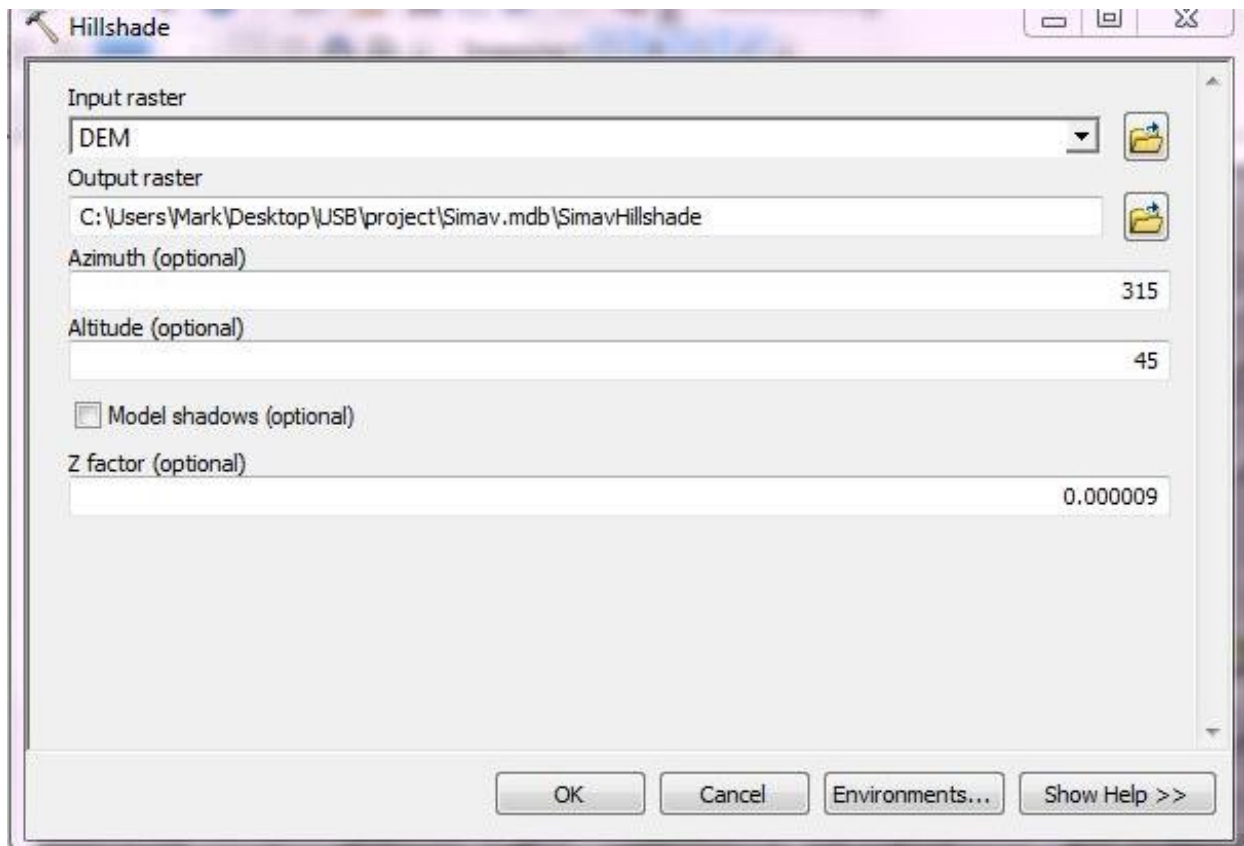
In order to see any river drainages and offsets that might have been influenced by the existence of a fault, I added another line feature class in ArcCatalog and gave it the name "rivers." I used the rivers that were already mapped on the Active Fault Map of Turkey to digitize the rivers. After turning the editor toolbar on, I started editing by creating line features for this class to represent the rivers. The result of this process is seen in **Figure 3.16**.



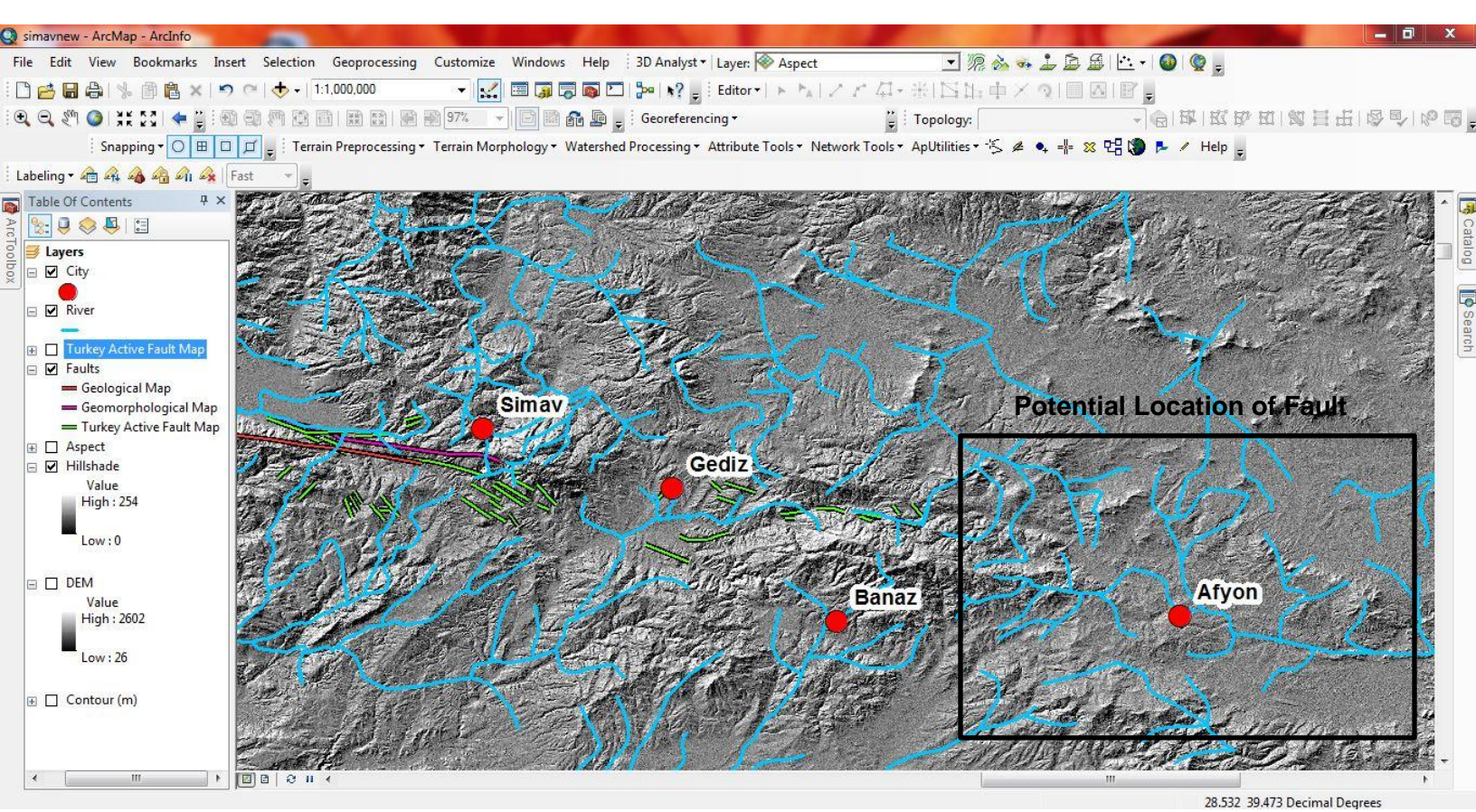
**Figure 3.16.** Map showing the digitized rivers with faults and cities. There seems to be some offset rivers surrounding the city of Banaz, and there is a linear trend displayed by some streams around Afyon. These locations might be a good place to check for the fault.

*Hillshade:*

The next step was use the Hillshade tool found in the Arc toolbox (**Figure 3.17**). This creates an image with shaded relief. The result of this is seen in **Figure 3.18**.



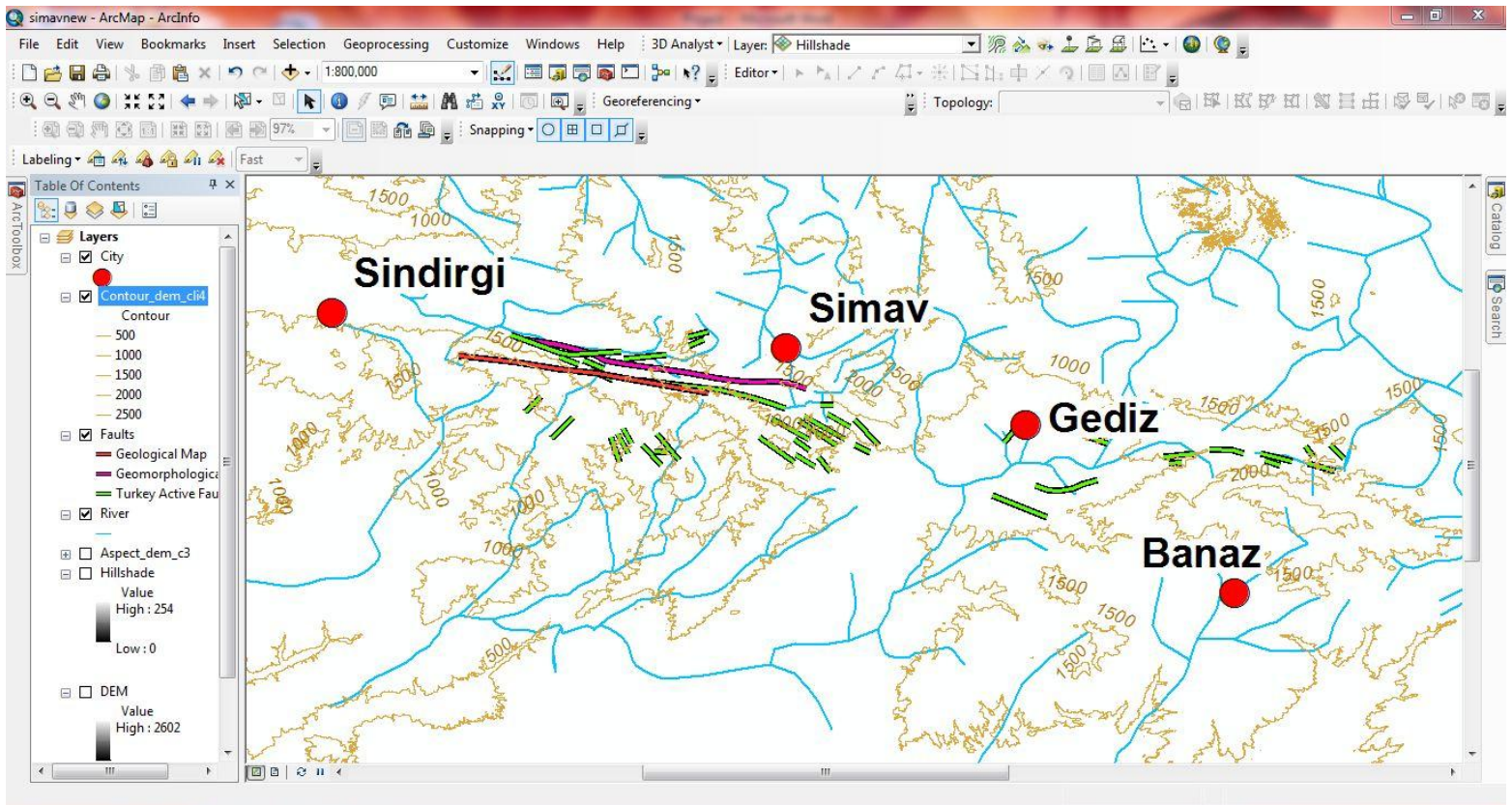
**Figure 3.17.** Creating a Hillshade Raster using the **Arc Toolbox**→**Spatial Analyst tools**→**Surface** →**Hillshade**. The Z factor is set to .000009.



**Figure 3.18.** Hillshade Raster with faults, cities, and rivers. The topography is seen more clearly here, and some offsets are present around the mapped faults. The linear trends in the figure are seen very clearly here, and this may suggest the existence of some type of structural feature such as a fault. This should be more clearly looked at in the field for possible indicators of a fault. The linear trends of the rivers around the city of Afyon may also suggest the existence of the Simav fault.

### *Contour:*

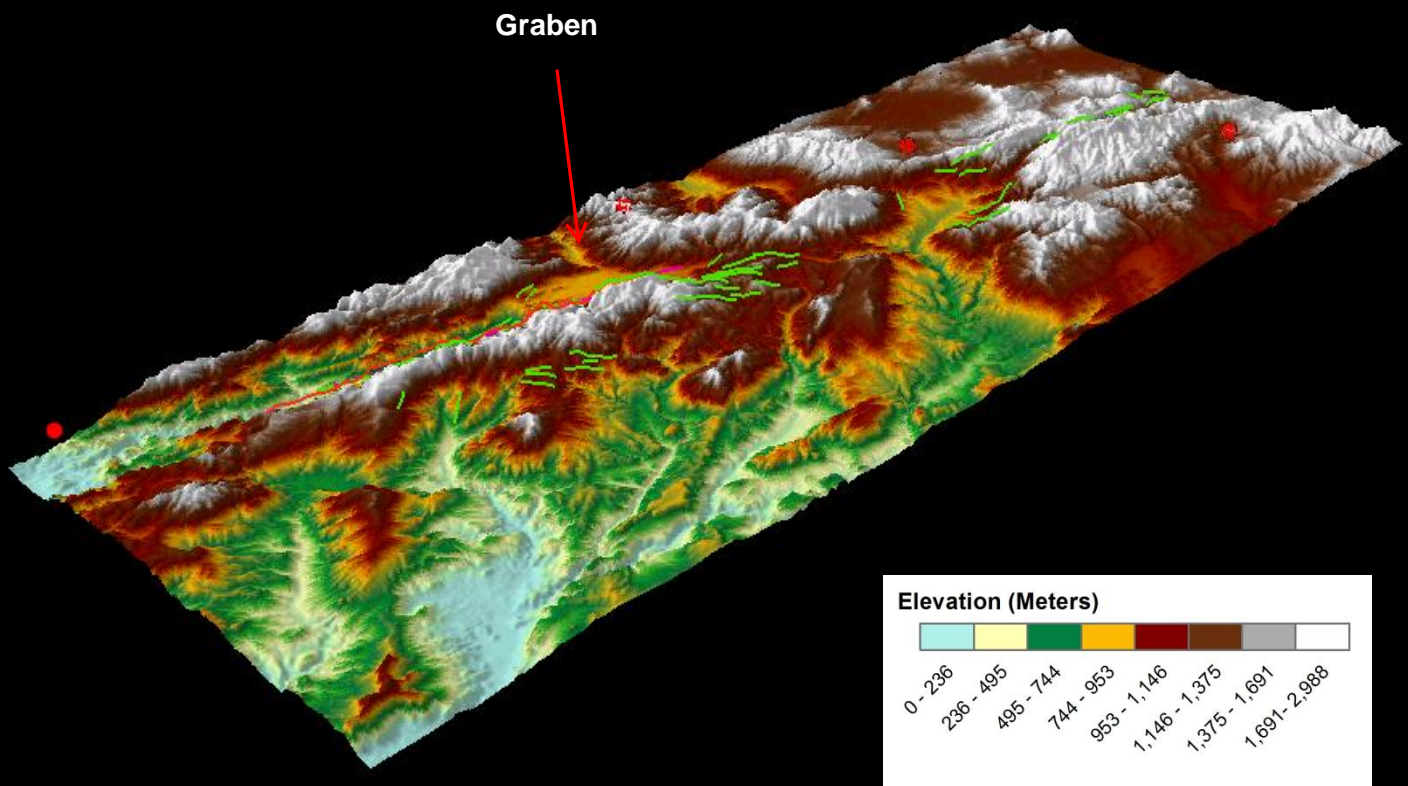
Topographic highs and low can be seen numerically with labeled contours (**figure 3.19**). Using the sequence: **ArcToolbox**→**Spatial Analyst tools**→**Surface**→**Contour**, contours with 500 m intervals were created. I also labeled these contours with the label manager.



**Figure 3.19.** Map showing the contours, cities, faults, and rivers. I used the DEM as the input raster and the contour interval was set to 500.

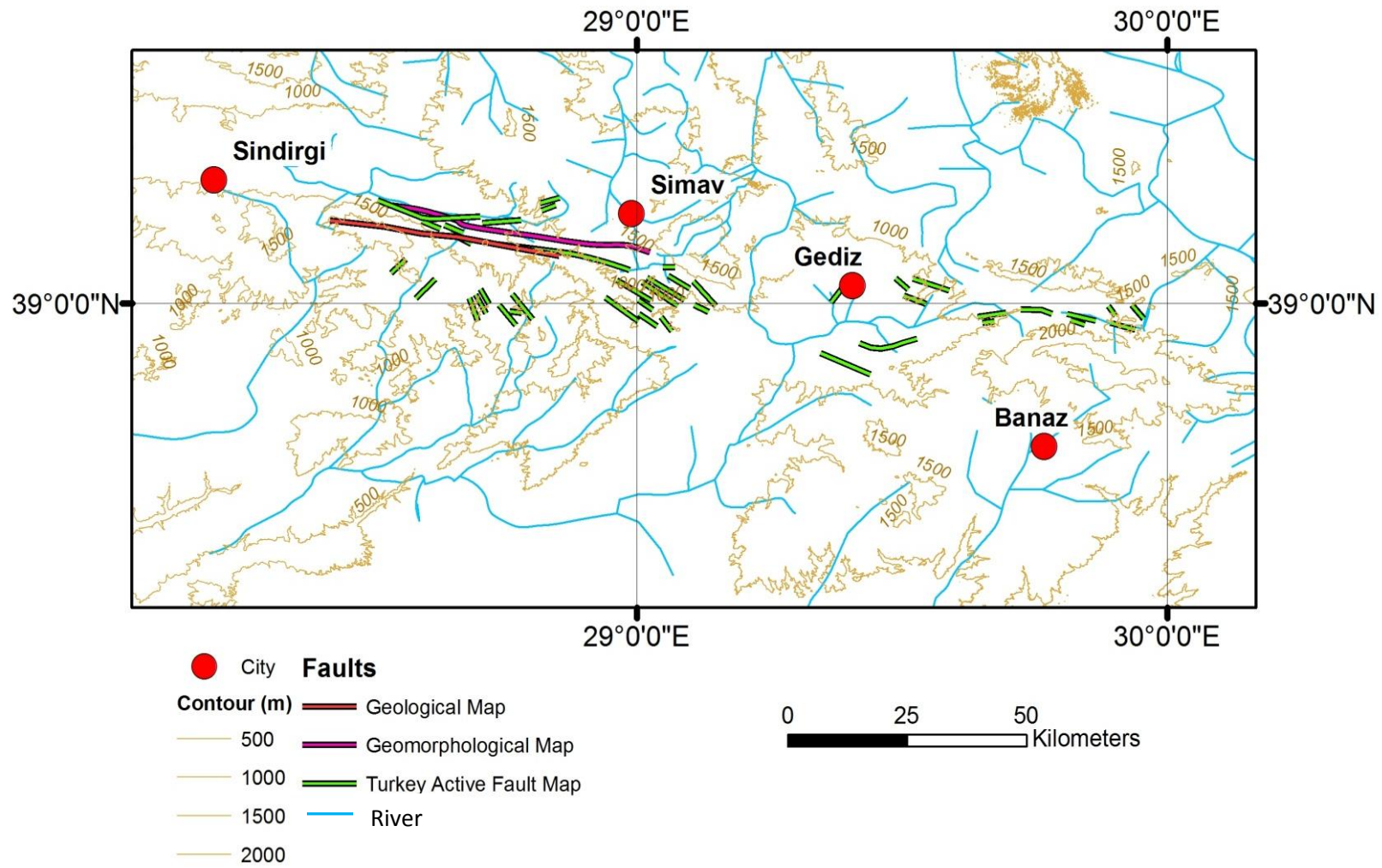
*ArcScene*

To further analyzing the data, I uploaded my DEM into ArcScene. Under View→Scene Properties, I set the vertical exaggeration to .00005. Under the properties for the DEM, I opened the Symbology tab and changed the colors of the layer to something more dynamic (Elevation 1). I then selected the Base Heights tab and chose “Floating on a custom surface.” I then clicked “Raster Resolution,” and set the Base Surface resolution values to those of the Original Surface resolution. I then selected the Rendering tab, and chose to “Shade aerial features relative to the scene’s light position. After adding the faults and cities, I went to their properties and under the Base Height’s tab, and I set the layer elevation offset to 1000 scene units. The result is seen in **Figure 3.20**.



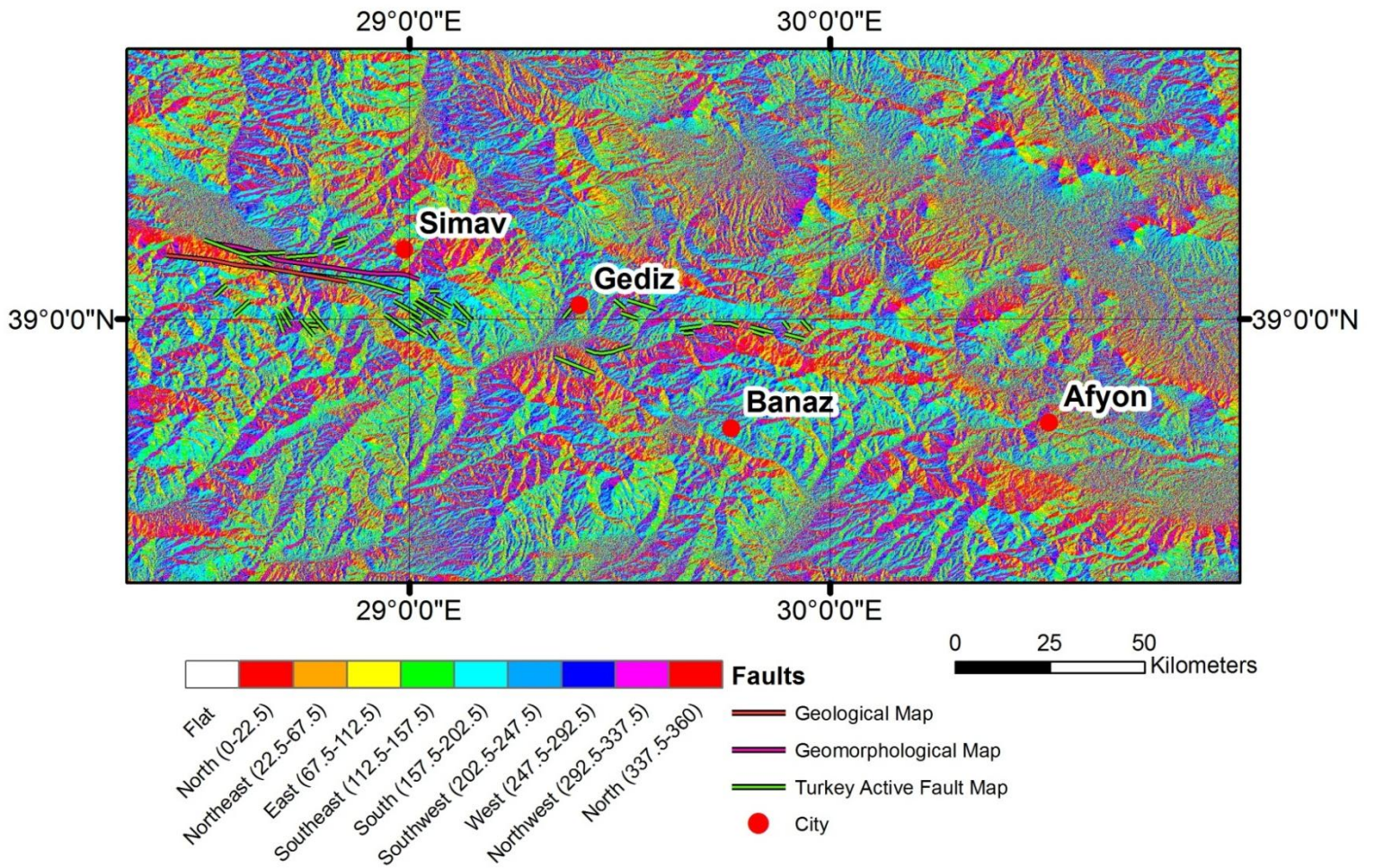
**Figure 3.20.** 3D DEM created in ArcScene with faults and cities. The elevation data is seen here, and I am able to see topographic breaks more clearly. Some offset rivers on either side of the faults are represented by the lower green and blue areas. The graben I pointed out earlier is also seen here at a lower elevation.

Final Maps

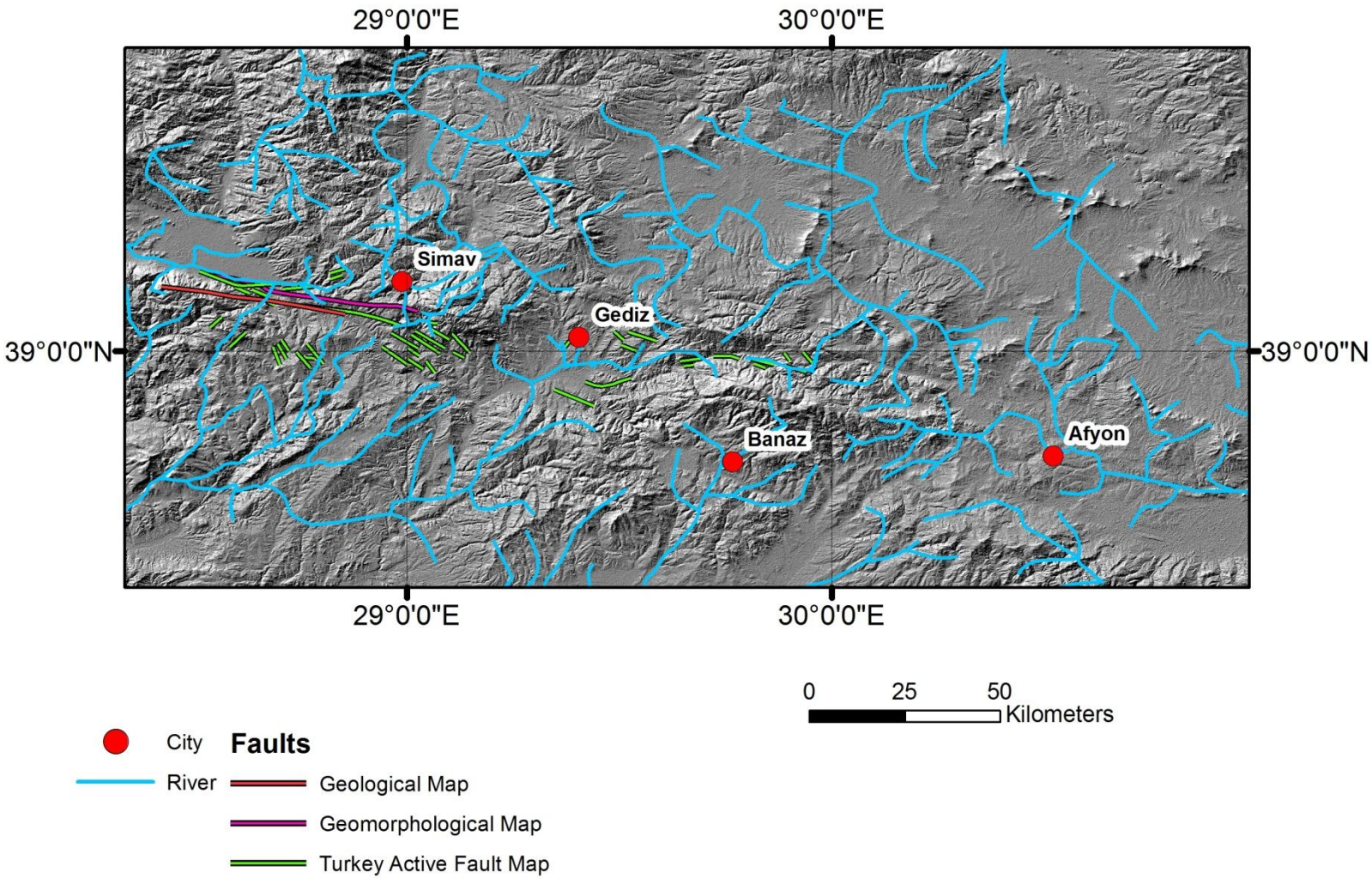


**Figure 4.1.** Map showing the contour lines, cities, faults, and rivers of the Simav region. A Grid was created in the properties settings of the layers using the Grids tab and choosing "New Grid."





**Figure 4.2.** Aspect figure created using **ArcToolbox**→**Spatial Analyst**→**Surface**→**Aspect**, and choosing the DEM as the input raster. The fault looks as though it is dipping mostly north.



**Figure 4.3.** Map showing the Hillshade raster of the region with the interpreted faults overlaid on top. The digitized rivers and cities are also shown here. Some linear streams are seen along the areas mapped with faults. Notice the strong NW-SE linear trend in the region. I plan on visiting the area around Afyon to search for signs of the existence of the Simav fault.

## **Conclusions and Future Work:**

The final maps provide detailed information of the Simav region. The river drainages and offsets, along with the various maps showing topography, have pointed me in the direction of conducting field work in the area to the southeast of the mapped faults around the city of Afyon. In the future, I plan on making more maps of the region with ArcGIS. In particular, I will use a [hydrology](#) tool found in the toolbar, which will define drainage areas and streams delineated through analysis of land surface topography. I will compare the already digitized rivers with the newly created ones, and get a better sense of where these rivers actually are compared to the topography data.