

Geologic map of the Robledo Mountains and vicinity  
Dona Ana County  
New Mexico

By

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## Robledo Geology Map

(Creation of Digital copy map from hard copy form for analysis)

Goal: The purpose of the creation of this map was to produce a digital product of the Robledo Geology Map (hard copy) that was produced by William R. Seager, John W. Hawley, and Frank E. Kottowski; and to allow myself to struggle with some of the process and techniques that are involved with creating a digital map and with using the varied tools and software involved. I have included a small description of the steps I performed, followed by the process I used to finish that step. Most steps are accompanied with graphics to allow the reader to graphically visualize what I did.

### Base Methodology:

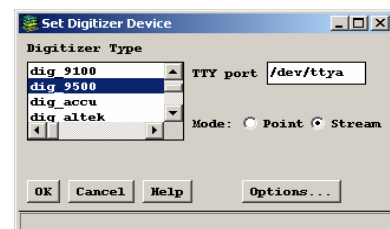
1. The GIS team first decides that scanning the maps would be far superior in production time because there would be less editing. From experience by other students, it was decided that the process of using the digitizing puck and digitizing tablet on the massive amounts of wavy lines would be too cumbersome and time consuming, because it is not possible to not follow the line as closely as needed to and additional time would have to be spent editing mistakes. We sent the maps to a scanning company in El Paso, where they used a high-end drum scanner to transfer the Robledo Mountain Map set; the north and south extent to achieve the limit of the map, the north and south maps to show all strike and dips, and labels, the cross – sections, and the stratigraphic columns. (1:24,000 scale) into a .tif file. Even though this may appear to be a faster process, the drum scanner does produce errors in the Y-axes (direction) of the map. This was the origin of the digital geologic line and area work (arcs, tics, points, and polygons).

2. The tic marks were created using the digitizing tablet and the Robledo Map using the grid intersection on the map, which they were then aligned with the DRGs (Digital Raster Graphics), ArcInfo 8.5 Workstation, and the ArcTools edit program. In this environment we were able to produce the tic mark map upon which the map and images we used would be based, so all data used would coincide and overlays with each other. In the directory we wanted to save our project, we created a new coverage named tic\_u, and along with the coverage I created a feature class called Tics. I then opened this feature class and was able to edit the coverage and create the tic marks.

### ArcInfo set up in arcedit environment using ArcTools:

Settings for Calcomp digitizer: In the ArcEdit Tool bar, under edit pull-down menu click the digitizer setup... option: settings are as follows:

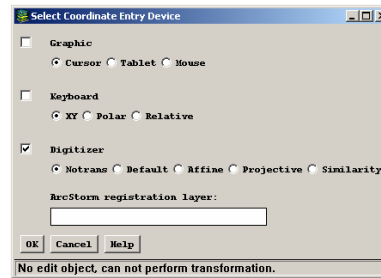
- Digitizer type = dig\_9500
- TTY Port = /dev/ttya



- *Mode = stream*

In the ArcTool bar, under edit pull-down menu click the Coordinate device option: settings are as follows:

- *Check mark the Digitizer option*
- *Choose default setting*
- *Begin digitizing*



another study area. was

2a. I also used the southern portion of (1:24,000 scale) map to obtain the whole This added to the total tics of the map. This accomplished in Arcinfo workstation by editing the tic\_u coverage and adding the tics from the coverage of the southern portion of the study area.

### Settings for adding additional features in a coverage:

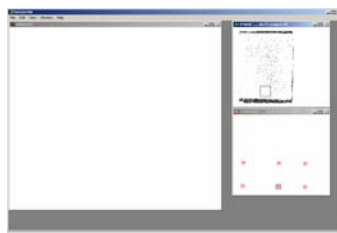
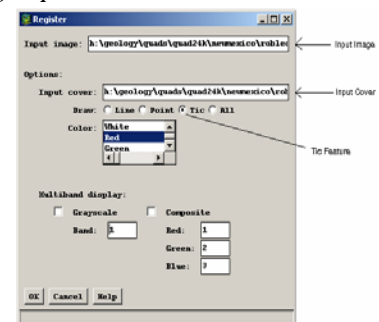
- *In the Arcinfo edit tools environment open the coverage you want to edit and choose the feature you want to work with (our case is tics)*
- *In the Edit tics edit tools that appear choose the “Get From Cover button”*



3. To obtain the correct location of the geologic features, the scanned image of the (1:24,000) map was geo-referenced or rectified to adjust the image closer to the true spatial location of the map and map tic marks. Also the tic marks were then aligned with the digital PLSS ( Public Land Survey System), which then the accuracy was confirmed by the comparing it to the DOQQ (Digital Orthophoto Quarter Quadrangles). This was done by using the command tools under the ArcEdit prompt. Rectification is the process where a raster dataset is transformed onto a different projection or the cell sizes are adjusted. In our case we wanted the image to coincide with the Tic map's projection ( UTM GCS NAD 1927) While preceding with this process, the RMS errors, no matter how close you think you got them to the correct position, were always above my comfort zone on allowing those points to stay. I didn't stop until I received a RMS error of ~0.000001 for both X and Y-axis, I was satisfied with those results.

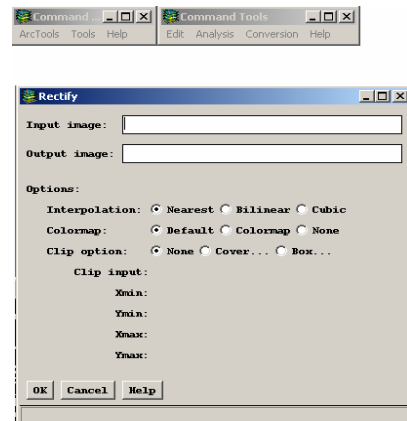
### Process for ArcTools, command tool subset prompt for rectification: step 1

- *Under edit pull-down menu in Command Tools, choose the image option.*
- *In the image option menu choose **register**.*
- *Here you input the image that you want to register and the coverage you want to register the image to. In our case I used the created tic\_u coverage to register this image.*
- *Under the Draw option choose the **tic** feature (this will draw only the tic marks)*
- *You will now begin registering the image to the desired coverage*
  - Here, I registered the approximate position of the tics on the image to the tic marks of the coverage.



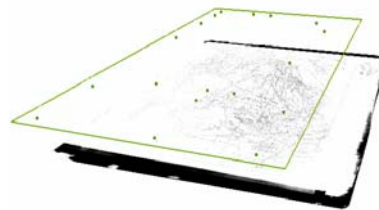
### Process for ArcTools command subset tools prompt for rectification: step 2

- Under edit pull-down menu in Command tools, choose the image option.
- In the image option menu now choose **rectify**.
- Put in the image that you have been working in the input image
- Type in the output (what you want to name the saved rectified image.)
- Under the Option section I chose the interpolation type as nearest (nearest neighbor) as my method of interpolating the image.
- This will produce a listing of your points and the residual error that is related to it, the residual error is the distance between the map coordinates (tic marks) and the transformed image. The entire error is calculated by combining the RMS amount of all the residuals to obtain the RMS error. The value you get shows how uniform the transformation is throughout the image and between the tic marks.
- The RMS error is displayed in ArcInfo (command tools prompt) in the map units you specify and digitizer inches.



If the RMS error was to high for my liking I would either choose to redo the process or delete points with high RMS errors. “If the RMS error is too high, you can reregister the appropriate control points. To maintain highly accurate data, the RMS error should be kept under 0.004 digitizer inches. For less accurate data, the value can be as high as 0.008 digitizer inches.” (ArcMap help menu)

(Image shows tic map overlaid onto image to show relation of image adjusting to tic marks)



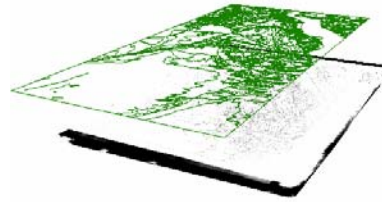
**The process of rectifying the image and other actions to produce a map that would be correctly spatially aligned took no more than one week of time, (working 20 hours a week).**

**4.** I began digitizing geological structure features off the Robledo Mt. (1:24,000 scale) map. The process of “on the fly digitizing” is done by having the image drawn underneath the coverage and then adding or “drawing in” the desired attributes. In this case it is arcs.

#### **Process:**

- I started adding arcs by selecting the coverage I wanted to edit, by opening it from the file pulldown menu the ArcEdit menu; I then select the feature I want to edit, which is arc.

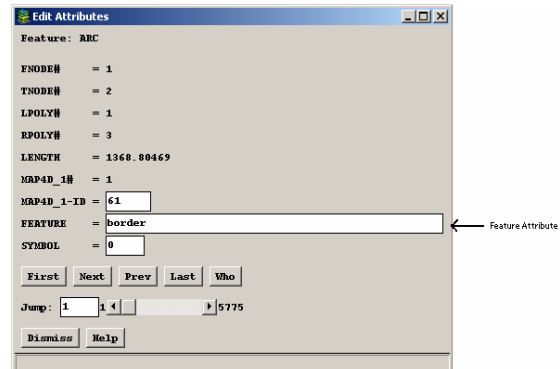
- I then chose the “add arc” button on the arc edit toolbar.
- I added arcs to the coverage by following the arc direction in the arc prompt.
- I attributed the arc with the appropriate field data
- I continued this process until I had finished digitizing all the contact features.
- I repeated the process to accommodate the fault features.



5. After an arc was created, an attribute field inside its attribute table was filled in correctly.

We created a column field that was named feature in which we inserted the type of feature we were adding. (Since we were digitizing a geologic map we filled in the attribute feature data field with the type of geological feature we were working on.).

After all the arc features were digitized and all the features were attributed with the correct data, intersecting the line work was next. This is done to add nodes to the line work where arcs crossed another arc. This was completed to further the process to create polygons from the line work, contacts, faults, inferred contact, etc... (Refer to data dictionary in back to obtain further data on all geologic data digitized).



**Duration:** The process of adding arcs, for contacts and faults took about three months of time, (working 20 hours a week). The process of adding the arcs did take more time than expected, due to the fact that when I began the image I was using was not yet rectified, so I had to redo all the arcs that I had already done.

6. The process of intersection was done in the ArcInfo prompt by using the intersecter and the clean commands. These next few tasks were done with very little headache. They were simple to accomplish but they were crucial to creating the final product. I accomplished these tasks by referring to the “Understanding GIS, The Arc/Info Method” book.

**The commands are:**

- In the arc prompt type... *USAGE INTERSECTERR*
- The program will reply with a message saying... *INTERSECTERR <cover>*
- Then type in *INTERSECTERR “THE NAME OF THE COVERAGE”* (without the quotes’), this intersects the lines work you have done and creates nodes for creating a polygon feature set later on.

**Next you need to Clean the line work:**

This is done so that you do not have any unnecessary dangles or undershoots. You are able to control the distance that the program considers a dangle by stating this in the clean command line.

**The commands are:**

- In the arc prompt we typed... *USAGE CLEAN.*
- You will see a reply that says... *Clean <in\_cover> {out\_cover} {dangle\_length} {fuzzy\_tolerance} {POLY | LINE}*
- Then you type... *CLEAN "The input coverage" "the coverage saved as something else" "the dangle length" (without the quotations only spaces)*
- You then should see your program execute... *<Cleaning>*  
*<Sorting...>*  
*<Intersecting...>*  
*<Assembling polygons...>*

**Then we created the polygon topology:**

- In the arc prompt we typed... *USAGE BUILD*
- The reply will be... *BUILD <cover> {POLY | LINE | POINT | NODE | ANNO.<subclass>}*
- Then type... *build "the desired coverage" "type of topology" (without the quotations/ topology in this case is polygons so type poly).*
- The arc program will then begin to build topology.

**The process of intersection, clean and build topology on arcs took 1.5 hours, due to the fact that I had to read about how to perform this and the trial and error to get this right.**

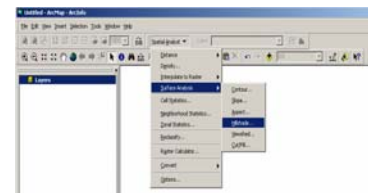
**7.** I needed to show relief on the final product so I used a hill shading of DEM (Digital Elevation Model) to show the relief. The DEMs I used were all from the RGIS website, (rgis.unm.edu, acquired on October 5, 2003) in the shared data. I used four adjacent quads: the Leasburg, Las Cruces, Dona Ana, and Picacho 1:24,000 quads. After acquiring these quads I had to merge them so they would align correctly.

**Merging Process:**

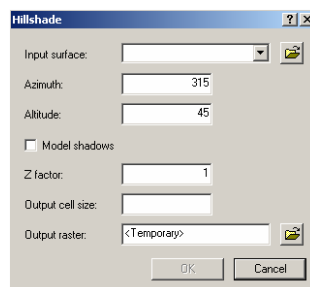
- Arc: *latticemerge <output file>*
- Enter the 1<sup>st</sup> quad
- Enter the 2<sup>nd</sup> quad
- Enter the 3<sup>rd</sup> quad
- Enter the 4<sup>th</sup> quad
  - This merged all four quads that I needed, and formed one image.

**Manipulating DEM to show Hill Shade:**

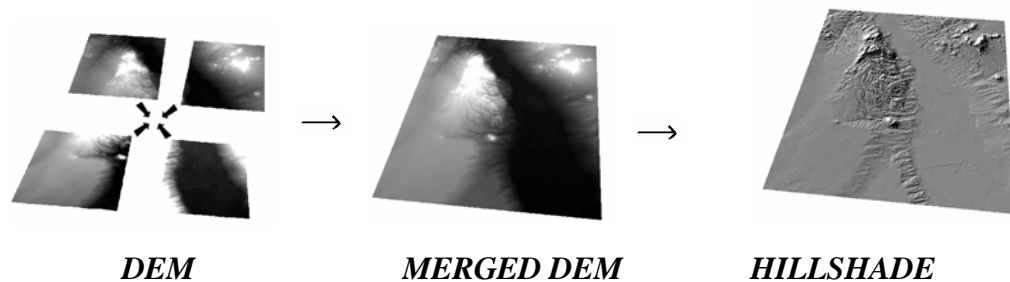
- Use Spatial Analyst extension in Arcmap navigate to the Spatial Analyst pulldown menu
- Choose the Surface Analysis dropdown menu and select the HILLSHADE
- Next place in the input surface space the merged DEM, next I chose the default named my output. Then wait for create the hill shade.



settings and then the program to



***Lattice Merge and Hill Shade process:***

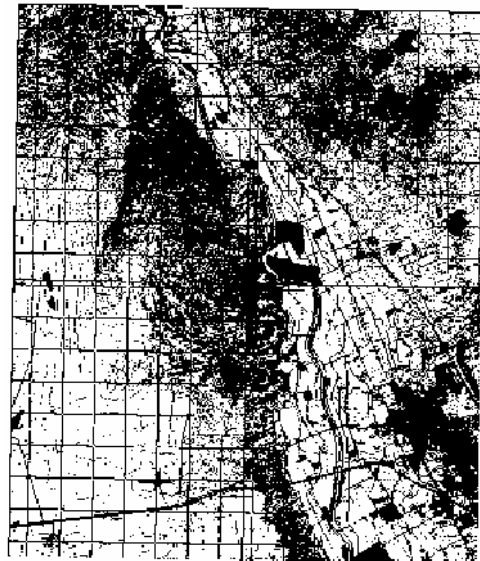


**The process of merging DEMs and creating hillshade took an hour to finish.**

**8.** Instead of using the relief mentioned above we decided to use a modified DRG for the purposes of showing contours and basemap properties.

**Modifying DRG Process:**

- First modify the DRG's (the four Quads that I have been using) by clipping the borders around the DRG, removing all data extending from the borders. (This was done in ArcView 3.3 with the DRG Clip extension)
- Next I merged the DRG's in the same manner that I stated above with the DEM data.
- After the merging process, I classified all data in two classes 0's and 1's. This was done so all data on the DRG could be adjusted to one uniform color (black) and all white space can be inputted as no data (clear)



**Conversion Methods Used:**  
**Coverage converted to Geodatabase**



## Cartographic Process:

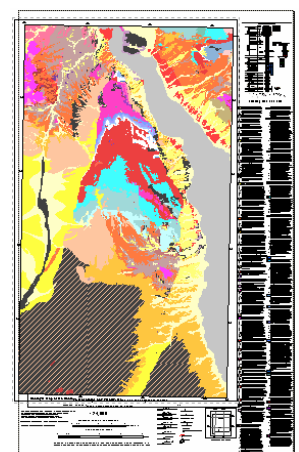
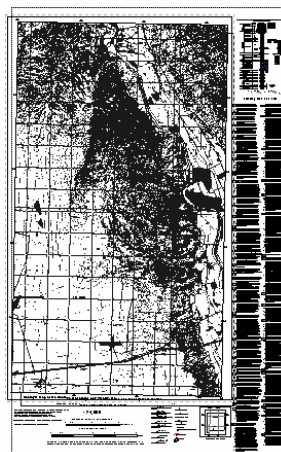
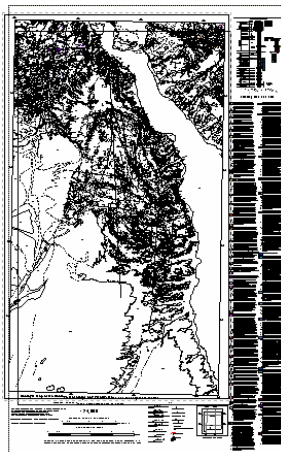
### Obtained and layered the base map information for the study area:

- *Road data: Interstate, Collector Streets, Arterials, and Trails. (arcs)*
- *Streams: Ephemeral fluvial systems within the Robledo Mountain area. (arcs)*
- *Rivers: River bed, washes, and shorelines (polygons)*
- *Railways: railroad tracks (arcs)*
- *Grid system: Public land Survey (polygons) and UTM (graticule)*
- *North arrow and magnetic declination ( $11^{1/2}$ )*
- *New Mexico boundary*
- *Legend*
- *Scale bars with scale text, and fractional scale (1:24,000)*
- *Locator map of study area in New Mexico*
- *Disclaimer*

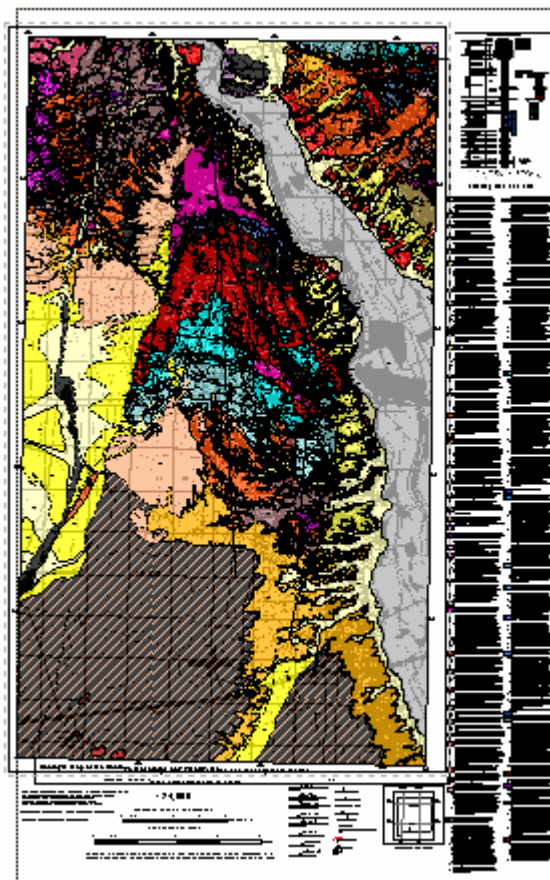
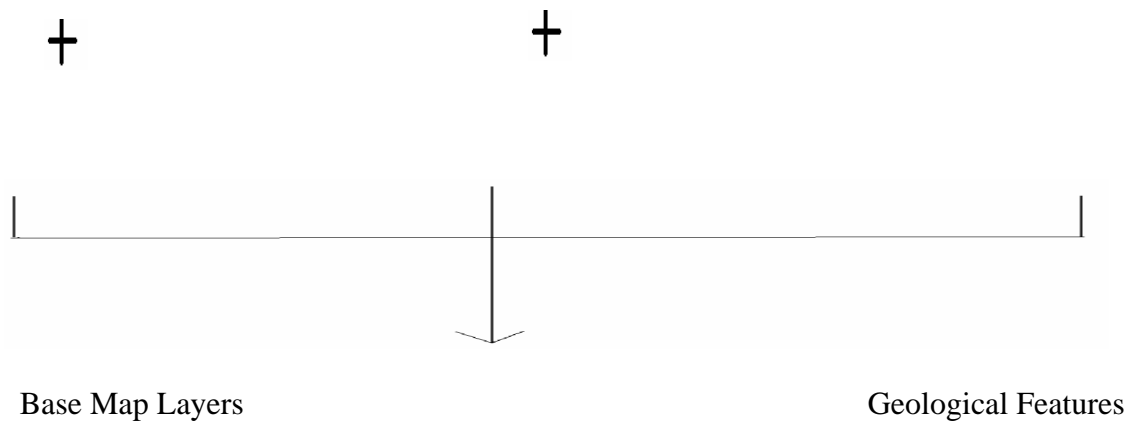
### Layered the geological features that were created:

- *Geological structure: Contacts (certain, inferred, concealed), anticlines, synclines, monoclines, faults (normal, concealed, inferred, thrust) (arcs)*
  - *Problems with the direction of the faults were corrected by flipping the direction of the line that was digitized. This was done to correctly align the direction of normal and thrust faults*
  - *This was achieved in ArcInfo workstation in the edit arc environment. Select the arc in question then using the “Flip” button on the tool menu. This flips the direction of the line.*
- *Geological formation:*
  - *Using the polygon topology feature class that was built earlier, the label class was put onto the polygon feature class to allow the polygons to draw them as labels. This was done in the ArcEdit environment by using the “get from cover” option and selecting the label coverage. This data was derived from a separate map*
  - *This was troublesome because some of the polygons weren’t attributed because the original map had missing data.*
- *Strikes and Dips*
- *Foliation points*
- *Relief of the Robledo Mountains*

With all this data that I manipulated and overlaid upon each other the final product is a map that shows the Geologic features of the four quads, two full quads and portions of two others, the Robledo Mountains.







## Data Dictionary

Arc Construction Data:

## Faults

- **Anticline** = attributed with attribute fields of **feature = anticline** and **symbol = 13**
  - **Concealed fault** = attributed with attribute fields of **feature = concealed fault** and **symbol = 7**
  - **Concealed Normal Fault** = attributed with attribute fields of **feature = Concealed Normal Fault** and **symbol = 4**
  - **Concealed Thrust Fault** = attributed with attribute fields of **feature = Concealed Thrust Fault** and **symbol =**
  - **Fault** = attributed with attribute fields of **feature = Fault** and **symbol = 2**
  - **Inferred Anticline** = attributed with attribute fields of **feature = Inferred anticline** and **symbol = 24**
  - **Inferred Fault** = attributed with attribute fields of **feature = Inferred Fault** and **symbol = 6**
  - **Inferred Normal Fault** = attributed with attribute fields of **feature = Inferred Normal Fault** and **symbol = 5**
  - **Monocline** = attributed with attribute fields of **feature = Monocline** and **symbol = 1**
  - **Normal Fault** = attributed with attribute fields of **feature = Normal Fault** and **symbol = 3**
  - **Syncline** = attributed with attribute fields of **feature = Syncline** and **symbol = 18**
  - **Thrust Fault** = attributed with attribute fields of **feature = Thrust Fault** and **symbol = 12**
- 

## Contact

- **Certain Contact** = attributed with attribute fields of **feature = certain contact** and **symbol = 8**
  - **Concealed Contact** = attributed with attribute fields of **feature = concealed contact** and **symbol = 35**
  - **Fault Contact** = attributed with attribute fields of **feature = fault contact** and **symbol = 67**
  - **Inferred Contact** = attributed with attribute fields of **feature = inferred contact** and **symbol = 34**
- 

## Transportation

- **Roads** = Interstate, Arterial, Collector Street, Trail, 4wd
  - **Railway** = Railroads
- 

## Point Data:

### Strike/Dip

- Apparent dip direction and amount
  - Strike and Dip of inclined bed
  - Strike and Dip of inclined foliation
  - Strike and Dip of overturned bed
  - Strike of vertical foliation
  - Vertical Bed
-

## **Polygon Construction Data:**

### **PLSS (Public Land Survey System)**

- Township/ Range/ Section
- 

### **River (Rio Grande)**

- Ditch or Canal
  - Inundation Area
  - Lake or Pond
  - Reservoir
  - Sewage Disposal Pond or Settling Basin
  - Stream
  - Wash or Ephemeral Drain
- 

### **Geologic Formation**

- Pennsylvanian
- Pennsylvanian- Desmoinesian- Derryman
- Pennsylvanian- Missourian
- Pennsylvanian- Virgilian
- Upper Devonian- Perch Sh.
- Mississippian
- Lower Ordovician- El Paso Fm.
- Upper Ordovician- Montoya Fm.
- Lower Permian (Wolfcampian)-Abo tongue
- Lower Permian- Bursum Fm.
- Lower Permian Hueco- Abo tongue
- Lower Permian Hueco- Basin facies
- Lower Permian Hueco- Abo, gastropod bearing member
- Lower Permian lower Hueco
- Lower Permian lower Hueco or Bursum equivalent
- Lower Permian middle Hueco
- Lower Permian Upper Hueco
- Upper Pleistocene to Holocene
- Quaternary Basin Alluvium
- Quaternary Camp Rice
- Quaternary Camp Rice coarse
- Quaternary Camp Rice fine
- Quaternary camp Rice medium
- Quaternary Camp Rice porphyry
- Quaternary Camp Rice T.
- Quaternary Camp Rice U.
- Quaternary P. A.
- Quaternary P. Y.
- Quaternary Rio Grande
- Quaternary Rio Grande Alluvium
- Quaternary Rio Grande Coarse
- Quaternary Rio Grande fine
- Quaternary Shalom Colony Fm. Alluvium

- Quarternry Shalom Colony Fm. Fine
- Quarternry Shalom Colony Fm. T.
- Silurian Fusselman Dolomite
- Miocene Or Oligocene- Andesite
- Miocene Basalt
- Oligocene- Bell Top Fm. 3
- Oligocene- Bell Top Fm. Basalt
- Oligocene- Andesite of Faulkner Canyon
- Oligocene- B.F R.
- Miocene- Basalt, Siltstone, Shale
- Oligocene- B.T. Limestone
- Oligocene- B.T U.
- Miocene or Oligocene F.
- Miocene or Oligocene flow banded rhyolite
- Miocene or Oligocene- Latite Poryphyry Dikes
- Eocene to Placeocene(?) Love Ranch Fm.
- Eocene Palm Park Gravelly
- Eocene Palm Park Fm.
- Oligocene- undifferentiated Rhyolite
- Tertiary- Rhyolite Porphyry, Robledo Rhyolite
- Miocene Rincon Valley Fm. Coarse
- Miocene Rincon Valley Fm. & Seldon Basalt
- Altered
- Onyx
- ss
- ss dikes

## **DEM Construction Data:**

### **DEM Quads:**

- Dona Ana
- Las Cruces
- Leasburg
- Picacho
- Merged DEMs
- Hillshade of DEM
- 

### **DRG**

- Dona Ana
- Las Cruces
- Leasburg
- Picacho
- Merged and Classified DRG