GEO 326G – Fall 2010

Plate Boundaries in the Tectonically Complex Region Known as the Woodlark Basin

By: Julianne Lamb

Lamb, Julianne E
12/2/2010

I. Introduction

A) Purpose: The main purpose of this project is to use a variety of datasets provided by the Internet and Dr. Barbara and Dr. David Tewksbury to evaluate and determine the nature of locations and types of plate boundaries in the Woodlark Basin region. The final product will be a series of topographic and bathymetric maps showing the volcanism, earthquake depths, seafloor ages, plate motion vectors, and plate boundary types, which ultimately determine the locations of the tectonic plates in the complex region.

B) Problem Formulation:

a. The Woodlark Basin is a tectonically complex region between the Pacific and Australian Plates that lacks plate boundary detail from many world plate maps. By downloading high resolution DEMs, I will analyze the bathymetry by looking for drastic elevation differences to determine the locations of convergent, divergent, and transform faults.

II. Data Collection

A) Data required for the modeling software that were not provided:

a. SRTM 90 meter resolution tiles – Digital Elevation Model (DEM). As with the SRTM tiles, the etopo1 data collection process proved to be a scrupulous one. I first found the SRTM data available for download at http://cgiar.org. In order to download the data for the specific coordinates (0S to 15S and 145E to 160E), downloading the Google Earth Interface (1 and 5 degree tiles) at http://www.ambiotek.com/srtm was required. **As shown in Figure 1.** My search results brought about a total of nine 5x5 degree zipped tile files and were only able to be downloaded from the London server.

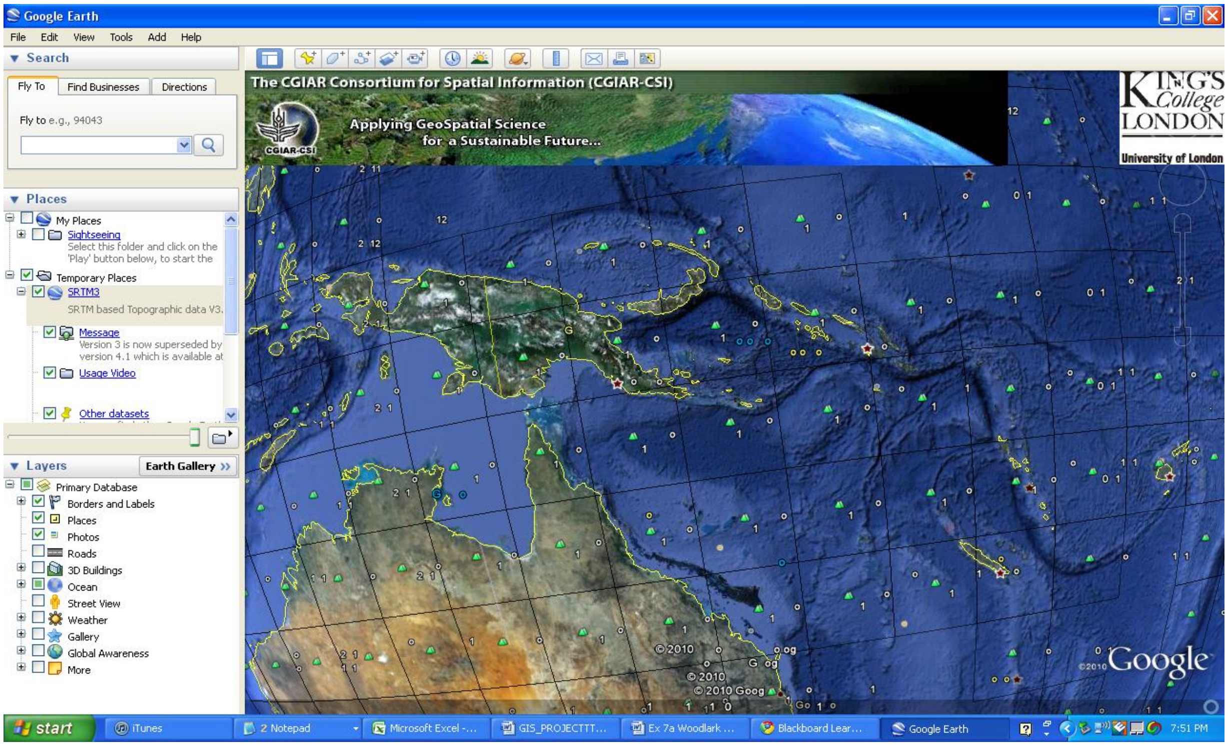


Figure 1: Selecting and downloading the appropriate SRTM tiles from CGIAR Google Interface

b. Etopo1 – World Topography and Bathymetry downloaded from http://www.ngdc.noaa.gov/mgg/global/global.html. For ArcGIS to be able to read the etopo1 file, it was necessary to download the grid-registered binary file titled etopo1_bed_g-f4.zip. **Described in II B).**

c. Earthquake data was available from the USGS Earthquake Hazards Program Database at http://earthquake.usgs.gov/. From the Earthquake Center page, I was able to search for the data using the Earthquake Catalog Search by choosing:

1. rectangular area
2. spreadsheet format
3. USGS/NEIC 1973-Present
4. parameters of 0S-15S and 145E-160E
5. set the minimum magnitude a 4.0, maximum at 9.9
6. set the start and end dates as 1980-2010
7. copy and pasted all data into the first cell in Microsoft Excel

d. World Volcano data was available from the Smithsonian Institution Global Volcanism Program website: http://www.volcano.si.edu/world/index.cfm.

1. downloaded Excel Summary List

e. World Continents layer: found at http://www.arcgis.com > Groups > ESRI Maps and Data. The file type was "ArcGIS Package Information" and was only able to be opened with "ArcGISFileHandler EXE". The World Continents layer file was not able to be opened using the DGS computers, and was only allowed to be viewed from ArcGIS on my personal laptop.

B) Data provided for analysis:

a. JPEG images
   1. Oceanic crust ages of the Woodlark Basin Region
   2. Vectors of crustal movement in the Woodlark Basin region

b. High resolution DEM of bathymetry for the Woodlark Basin region

III. Data Processing

1) After downloading the SRTM tiles from the Google Interface provided by CGIAR, I extracted all nine of the tiles which were already characterized as following after being added into ArcCatalog: nine 68.66 MB continuous raster TIFF files, 6000 x 6000 columns and rows, cell size of 0. 000833333, 0.000833333, 16 bit signed integer, and the defined projection GCS_WGS_1984. **See Figure 2.**

a. Mosaicing the 9 DEMs together
   1. Create a new Personal Geodatabase
   2. Used "ArcToolbox>Data Management Tools>Raster Dataset>Mosaic"; program failed to execute
   3. "ArcToolbox>Data Management Tools>Raster Dataset>Mosiac to New Raster"
   4. Created a Personal Geodatabase Raster Database by imputing all 9 DEMs, using the coordinate system information of one of the DEMS for "Coordinate system for the raster", chose same pixel type (16_BIT_SIGNED), and a cell size of (0.00083333, 0.00083333) and named the output file "RasDSet_new". New raster was not projected.

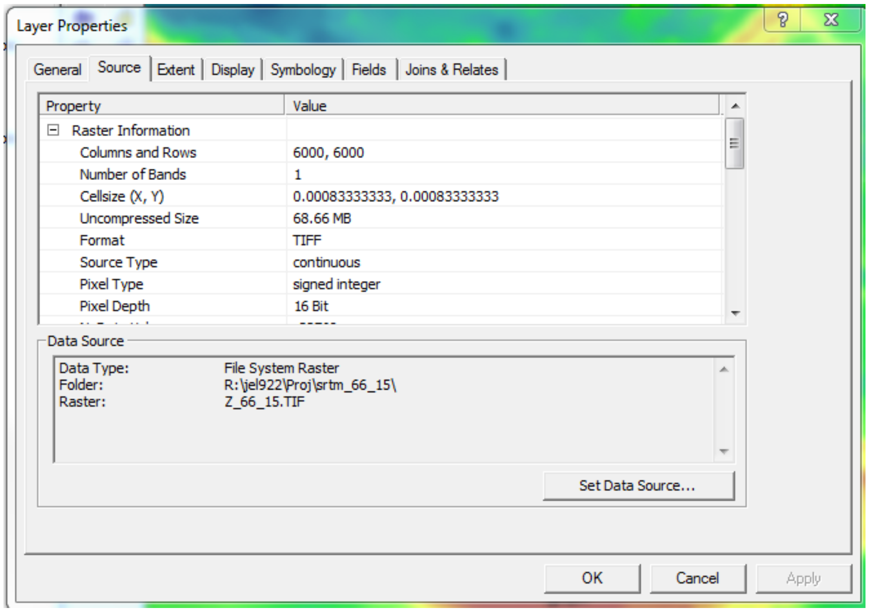


Figure 2: ArcCatalog example of the Layer Properties seen in one of the nine SRTM tiles

2) After downloading the grid-registered binary file titled etopo1_bed_g-f4.zip file, the file was extracted and then added to ArcCatalog for conversion processes. Choosing to download the f4 file was a crucial process and a tedious one as well; the NGDC website gives 4 different file types available for download, each containing 4 different zip files at 1.4 GB each. After extraction and implementation of every file, except for f4, every file failed to open in ArcCatalog. F4 was the last choice, and inopportunely, the correct one.
   a. Within ArcCatalog, use the "Float to Raster" conversion tool and input the existing extracted etopo1 file into "Input floating point raster file". Create new raster.
   b. Clipping the etopo1 DEM to the same size as the SRTM DEM in ArcCatalog
      1. We want to create a new shapefile in the folder where the project is saved: "New>Shapefile" and choose polygon with the coordinate system to GCS>WGS84
      2. Opened a new ArcMap project and added the etopo1 DEM and the new shapefile.
      3. Turn on Editor toolbar and "Editor menu>Options>Units" and set to Polar and Decimal Degrees. In the editor toolbar with the new shapefile chosen, choose the pencil tool and right-click on the map to enter "Absolute X,Y". Enter the Xs (longitudes) and Ys (latitudes) of the four corners desired for clipping extent by right clicking on the map and using the "Absolute X,Y" option each time. "Finish sketch", stop editing, and save edits.

4. Go to “Arctoolbox>Data Management Tools>Raster> Raster Processing> Clip”; Input etopo1 file, check box for “Use Input Features for Clipping Geometry” and add new polygon shape file as the “Output Extent”. Add new raster to ArcMap and delete the large, world-sized unclipped etopo1 raster. **Refer to Figure 3.**

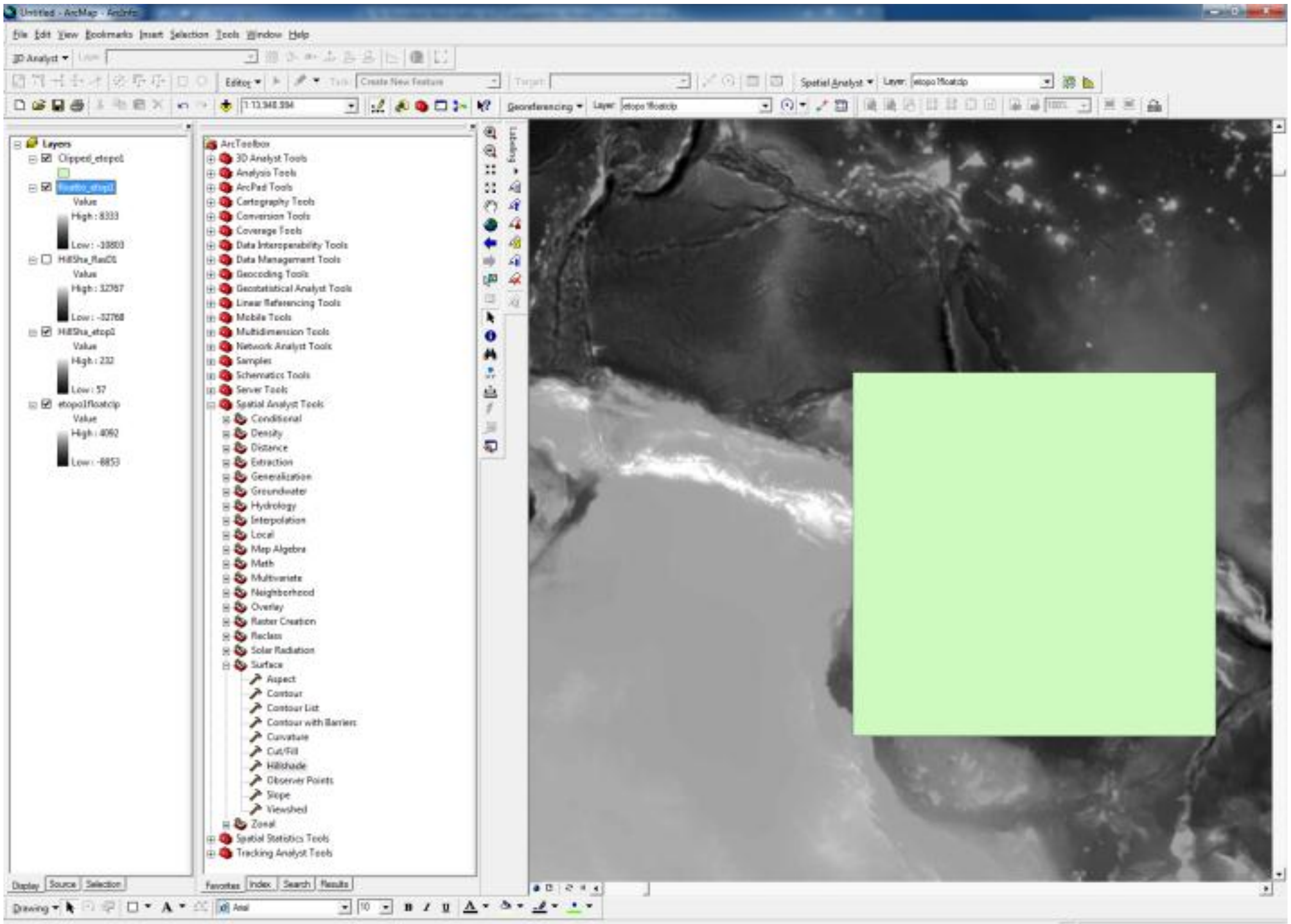
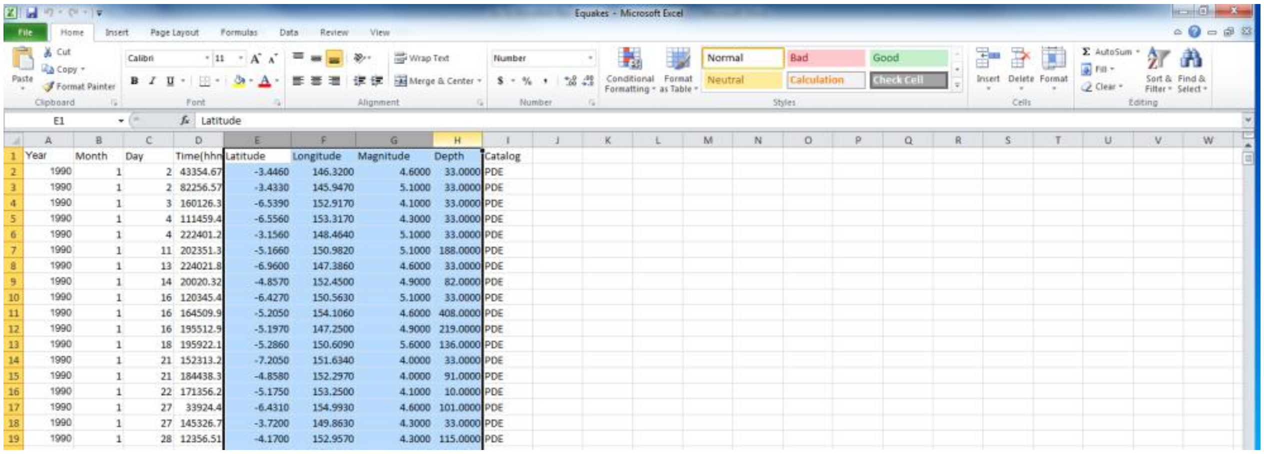


Figure 3: Etopo1 overlain by shapefile clipped to area of interest. Goal: the DEM will be clipped to the area comprised by the shapefile after using the Clip tool.

3) After downloading the Earthquake data and pasting it into Excel, we need to format the cells in the latitude, longitude, magnitude, and depth columns to having decimal places set to 4.

a. To get data into separate columns: “Data>Text to columns>Delimited>next>comma (uncheck Tab)>next>finish”

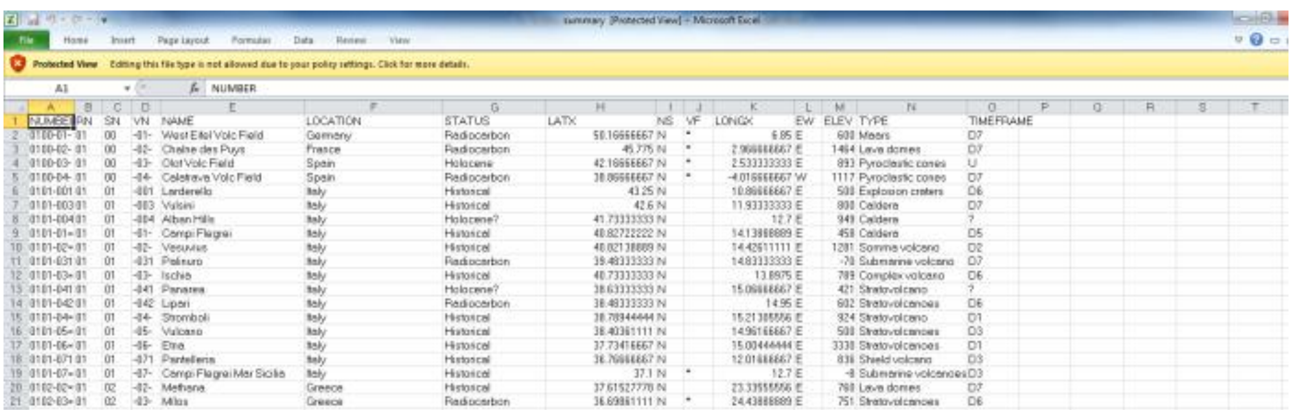
b. Selected latitude, longitude, magnitude, and depth columns and Formated cells by choosing “Format>Cells>Format Cells>Number and choose 4. **See Figure 4.**



	A	B	C	D	E	F	G	H	I
1	Year	Month	Day	Time(hhm	Latitude	Longitude	Magnitude	Depth	Catalog
2	1990	1	2	43354.67	-3.4460	146.3200	4.6000	33.0000	PDE
3	1990	1	2	82256.57	-3.4330	145.9470	5.1000	33.0000	PDE
4	1990	1	3	160126.3	-6.5390	152.9170	4.1000	33.0000	PDE
5	1990	1	4	111459.4	-6.5560	153.3170	4.3000	33.0000	PDE
6	1990	1	4	222401.2	-3.1560	148.4640	5.1000	33.0000	PDE
7	1990	1	11	202351.3	-5.1660	150.9820	5.1000	188.0000	PDE
8	1990	1	13	224021.8	-6.9600	147.3860	4.6000	33.0000	PDE
9	1990	1	14	20020.32	-4.8570	152.4500	4.9000	82.0000	PDE
10	1990	1	16	120345.4	-6.4270	150.5630	5.1000	33.0000	PDE
11	1990	1	16	164509.9	-5.2050	154.1060	4.6000	408.0000	PDE
12	1990	1	16	195512.9	-5.1970	147.2500	4.9000	219.0000	PDE
13	1990	1	18	195922.1	-5.2860	150.6090	5.6000	136.0000	PDE
14	1990	1	21	152313.2	-7.2050	151.6340	4.0000	33.0000	PDE
15	1990	1	21	184438.3	-4.8580	152.2970	4.0000	91.0000	PDE
16	1990	1	22	171356.2	-5.1750	153.2500	4.1000	10.0000	PDE
17	1990	1	27	33924.4	-6.4310	154.9930	4.6000	101.0000	PDE
18	1990	1	27	145326.7	-3.7200	149.8630	4.3000	33.0000	PDE
19	1990	1	28	12356.51	-4.1700	152.9570	4.3000	115.0000	PDE

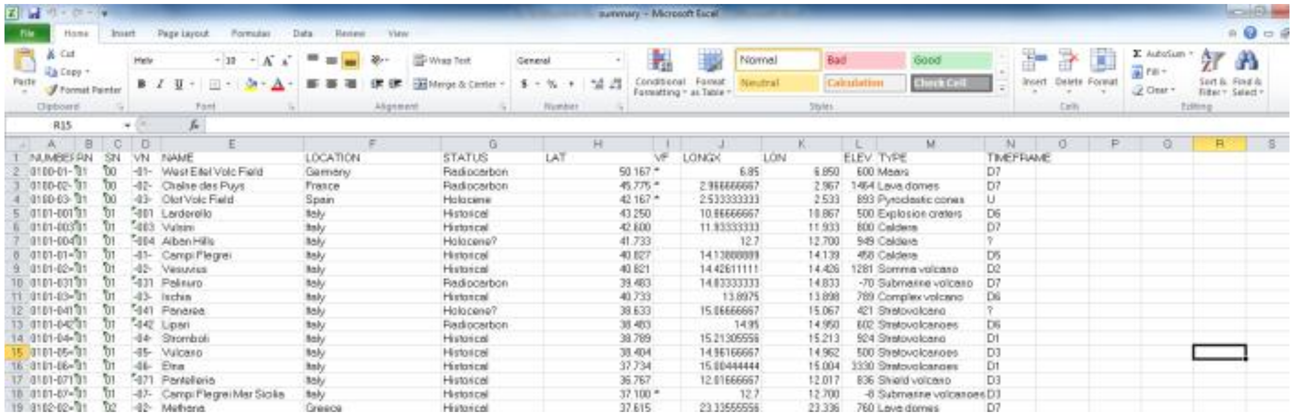
Figure 4: Excel spreadsheet showing earthquake data from area of interest in separate columns

4) After having successfully downloaded the Excel spreadsheet of the World volcano data from the Smithsonian Institution Global Volcanism Program, we need to check and edit our data to make sure that our latitudes and longitudes have correct negative signs in front of them before adding them to ArcMap. **Figures 5 and 6** represent the before and after spreadsheets with adjusted decimal places and latitude and longitude notation



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	NUMBE	RN	SN	VN	NAME	LOCATION	STATUS	LATX	NS	VF	LONGX	EW	ELEV	TYPE	TIMEFRAME
2	0100-01-	01	00	-01-	West Eifel Volc Field	Germany	Radiocarbon	50.16666667	N	*	6.85	E	600	Maars	D7
3	0100-02-	01	00	-02-	Chaine des Puys	France	Radiocarbon	45.775	N	*	2.966666667	E	1464	Lava domes	D7
4	0100-03-	01	00	-03-	Olot Volc Field	Spain	Holocene	42.16666667	N	*	2.533333333	E	893	Pyroclastic cones	U
5	0100-04-	01	00	-04-	Calatrava Volc Field	Spain	Radiocarbon	38.86666667	N	*	-4.016666667	W	1117	Pyroclastic cones	D7
6	0101-001	01	01	-001	Larderello	Italy	Historical	43.25	N		10.86666667	E	500	Explosion craters	D6
7	0101-003	01	01	-003	Vulsini	Italy	Historical	42.6	N		11.93333333	E	800	Caldera	D7
8	0101-004	01	01	-004	Alban Hills	Italy	Holocene?	41.73333333	N		12.7	E	949	Caldera	?
9	0101-01=	01	01	-01-	Campi Flegrei	Italy	Historical	40.82722222	N		14.13888889	E	458	Caldera	D5
10	0101-02=	01	01	-02-	Vesuvius	Italy	Historical	40.82138889	N		14.42611111	E	1281	Somma volcano	D2
11	0101-031	01	01	-031	Palinuro	Italy	Radiocarbon	39.48333333	N		14.83333333	E	-70	Submarine volcano	D7
12	0101-03=	01	01	-03-	Ischia	Italy	Historical	40.73333333	N		13.8975	E	789	Complex volcano	D6
13	0101-041	01	01	-041	Panarea	Italy	Holocene?	38.63333333	N		15.06666667	E	421	Stratovolcano	?
14	0101-042	01	01	-042	Lipari	Italy	Radiocarbon	38.48333333	N		14.95	E	602	Stratovolcanoes	D6
15	0101-04=	01	01	-04-	Stromboli	Italy	Historical	38.78944444	N		15.21305556	E	924	Stratovolcano	D1
16	0101-05=	01	01	-05-	Vulcano	Italy	Historical	38.40361111	N		14.96166667	E	500	Stratovolcanoes	D3
17	0101-06=	01	01	-06-	Etna	Italy	Historical	37.73416667	N		15.00444444	E	3330	Stratovolcanoes	D1
18	0101-071	01	01	-071	Pantelleria	Italy	Historical	36.76666667	N		12.01666667	E	836	Shield volcano	D3
19	0101-07=	01	01	-07-	Campi Flegrei Mar Sicilia	Italy	Historical	37.1	N	*	12.7	E	-8	Submarine volcanoes	D3
20	0102-02=	01	02	-02-	Methana	Greece	Historical	37.61527778	N		23.33555556	E	760	Lava domes	D7
21	0102-03=	01	02	-03-	Milos	Greece	Radiocarbon	36.69861111	N	*	24.43888889	E	751	Stratovolcanoes	D6

Figure 5: Worldwide volcanic data in Excel spreadsheet with incorrect formating.



NUMBER	AN	SN	VN	NAME	LOCATION	STATUS	LAT	VF	LONGX	LON	ELEV	TYPE	TIMEFRAME
0100-01-	01	00	-01-	West Eifel Volc Field	Germany	Radiocarbon	50.167	*	6.85	6.850	600	Maars	D7
0100-02-	01	00	-02-	Chaine des Puys	France	Radiocarbon	45.775	*	2.966666667	2.967	1464	Lava domes	D7
0100-03-	01	00	-03-	Olot Volc Field	Spain	Holocene	42.167	*	2.533333333	2.533	893	Pyroclastic cones	U
0101-001	01	01	-001	Larderello	Italy	Historical	43.250		10.86666667	10.867	500	Explosion craters	D6
0101-003	01	01	-003	Vulsini	Italy	Historical	42.600		11.93333333	11.933	800	Caldera	D7
0101-004	01	01	-004	Alban Hills	Italy	Holocene?	41.733		12.7	12.700	949	Caldera	?
0101-01-	01	01	-01-	Campi Flegrei	Italy	Historical	40.827		14.13888889	14.139	458	Caldera	D5
0101-02-	01	01	-02-	Vesuvius	Italy	Historical	40.821		14.42611111	14.426	1281	Somma volcano	D2
0101-031	01	01	-031	Palinuro	Italy	Radiocarbon	39.483		14.83333333	14.833	-70	Submarine volcano	D7
0101-03-	01	01	-03-	Ischia	Italy	Historical	40.733		13.8975	13.898	789	Complex volcano	D6
0101-041	01	01	-041	Panarea	Italy	Holocene?	38.633		15.06666667	15.067	421	Stratovolcano	?
0101-042	01	01	-042	Lipari	Italy	Radiocarbon	38.483		14.95	14.950	602	Stratovolcanoes	D6
0101-04-	01	01	-04-	Stromboli	Italy	Historical	38.789		15.21305556	15.213	924	Stratovolcano	D1
0101-05-	01	01	-05-	Vulcano	Italy	Historical	38.404		14.96166667	14.962	500	Stratovolcanoes	D3
0101-06-	01	01	-06-	Etna	Italy	Historical	37.734		15.00444444	15.004	3330	Stratovolcanoes	D1
0101-071	01	01	-071	Pantelleria	Italy	Historical	36.767		12.01666667	12.017	836	Shield volcano	D3
0101-07-	01	01	-07-	Campi Flegrei Mar Sicilia	Italy	Historical	37.100	*	12.7	12.700	-8	Submarine volcanoes	D3
0102-02-	01	02	-02-	Methana	Greece	Historical	37.615		23.33555556	23.336	760	Lava domes	D7

Figure 6: Corrected Worldwide volcanic data in Excel spreadsheet with decimal place limit and corresponding negative signs for southern latitudes and western longitudes under “LAT” and “LON”.

5) Next, we want to hillshade the clipped etopo1, mosaicked SRTM, and the Woodlark DEM. With ArcCatalog open, add the three above files. All three of the files should still not be projected, yet all of the data should be the same using GCS_WGS_84.

   a. Open the Hillshade tool in the ArcToolbox: “ArcCatalog>ArcToolbox>Spatial Analyst>Surface>Hillshade”

   b. Using the Hillshade tool, correct the z-factor for each raster to 0.00000912. This number represents the conversion factor for low latitudes to convert our elevation values in meters to decimal degrees; X, Y, and Z must all have the same units. **Refer to Figures 7 and 8.**

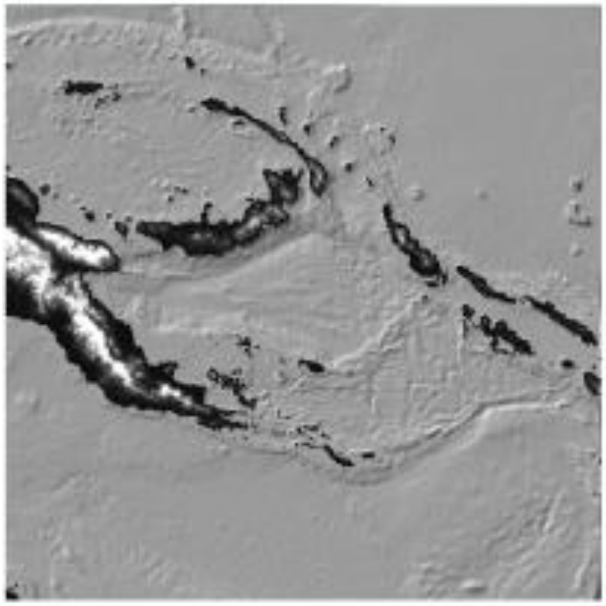


Figure 7: After performing one hillshade operation in ArcCatalog, layers were added to ArcMap: Hillshaded etopo1 raster overlain by unhillshaded SRTM mosaic.

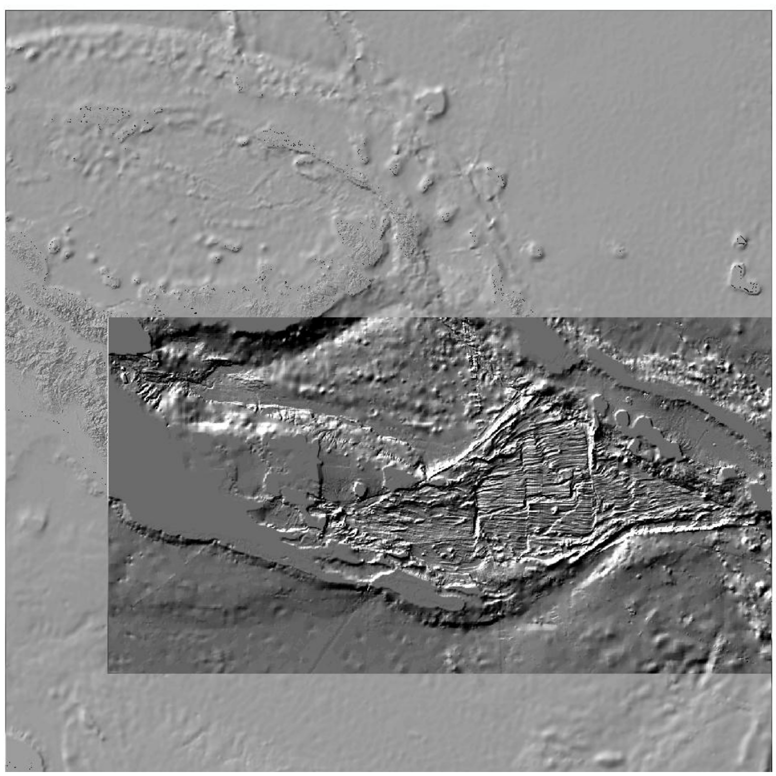


Figure 8: Hillshades performed on all three DEMs. Etopo1 and its hillshade on bottom, then SRTM hillshade DEM above, and Woodlark hillshade DEM on top

6) After adding all three of the clipped DEMs as well as their hillshades to ArcMap, use the Display tab in each of the layer's Properties window to set all of the hillshade layers settings to Contrast = 30; Brightness = 5; Transparency = 50 to make the hillshades more dynamic. For the SRTM DEM, choose a color ramp that resembles land (SRTM is topography) and for the bathymetric DEMs choose the "Spectrum Full Bright" color ramp and click the invert button to make the smallest values blue. Also, in the Table of Contents, place the etopo1 DEM on the very bottom with its hillshade on top, then the SRTM and it's hillshade, and finally the Woodlark Basin DEM with its hillshade overlying the DEM. Finally, within the Symbology tab for the etopo1 DEM, use the Statistics box to chose "From Custom Settings" and set the minimum and maximum values to match the minimum and maximum values of the values used in the Woodlark DEM. We do this to attempt to merge the two DEMs seamlessly, although there is a slight difference in color due to resolution differences within the two DEMs. By placing the layers in this order and by modifying the settings within the Display tab, we are able to get a map that shows dynamic topographic elevations within the Woodlark Basin region. **See Figure 9 below.**

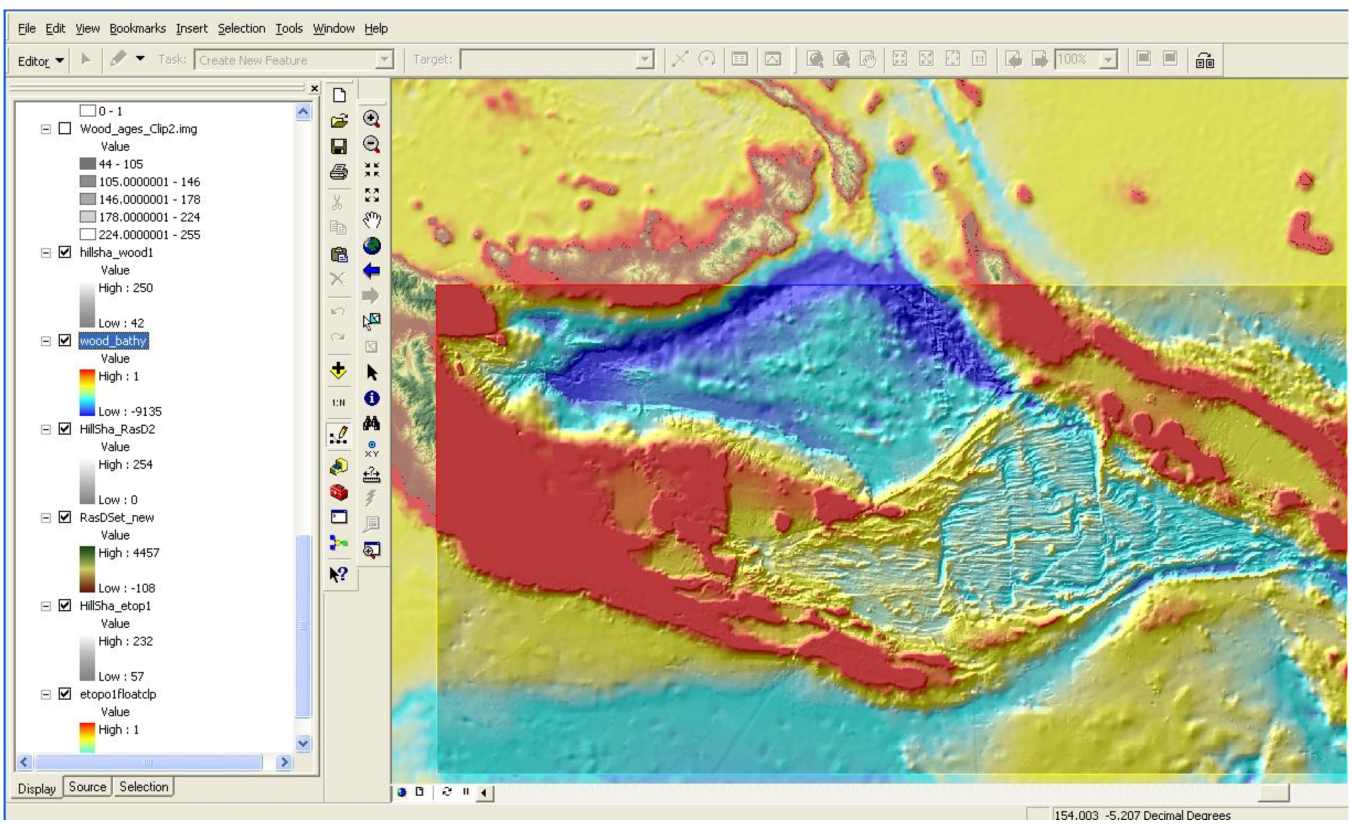


Figure 9: Depiction of the brightened, contrasted, transparent hillshade layers overlaying their corresponding colored and corrected DEMs.

7) Next, we are going to add the volcano and earthquake data that was previously prepared in Excel.

a. Add the World volcanoes Excel file to ArcMap, and set the X to LON and the Y to LAT. Choose to import Coordinate System and select one of the DEMs already created. Choosing this will automatically give the volcanoes file the Coordinate System of all of the particular GCS data. Create a shapefile by exporting the Events layer and then use the polygon shapefile (created to clip the etopo1) to clip the new World volcanoes shapefile: “Selection>Select by Location” then Select features from “Export_volc” that “are within” the “Clipped_etopo1” to get the volcanoes within the clipped shapefile. Notice that the only volcanoes present are the ones within the etopo1 boundaries. **See Figure 10 Below.**

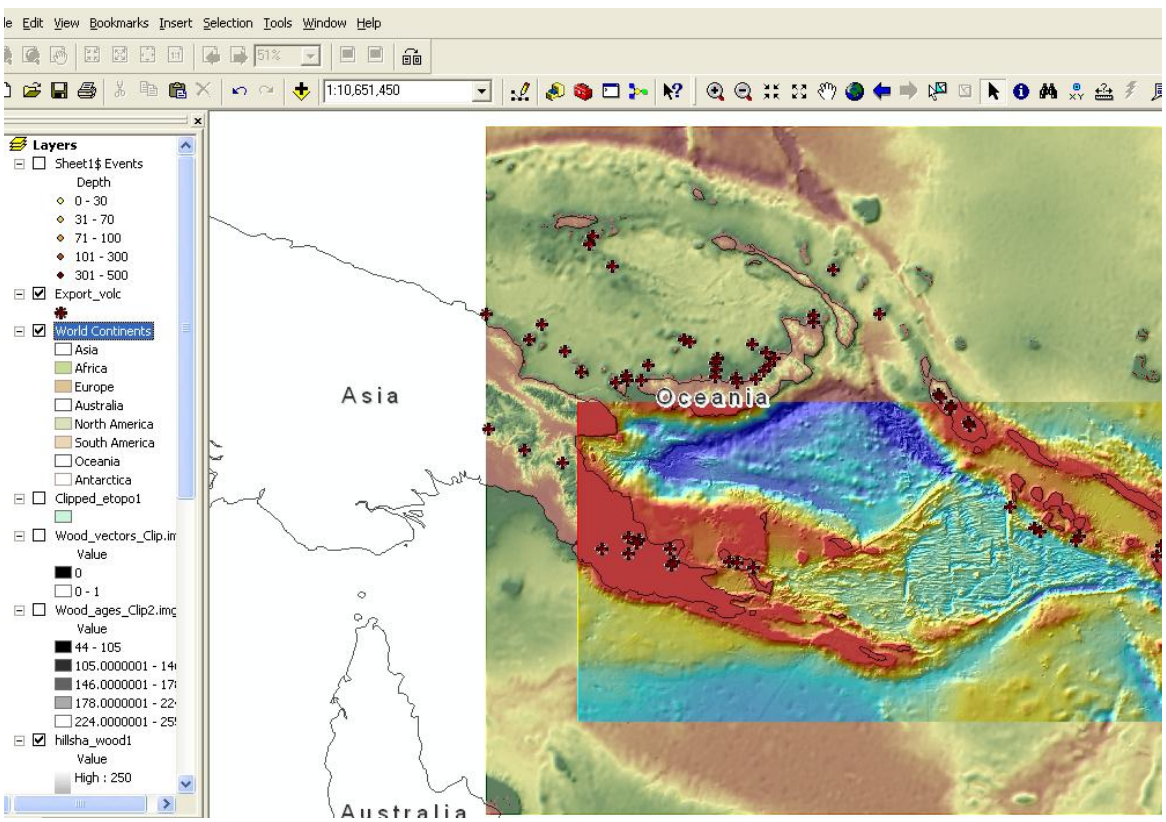
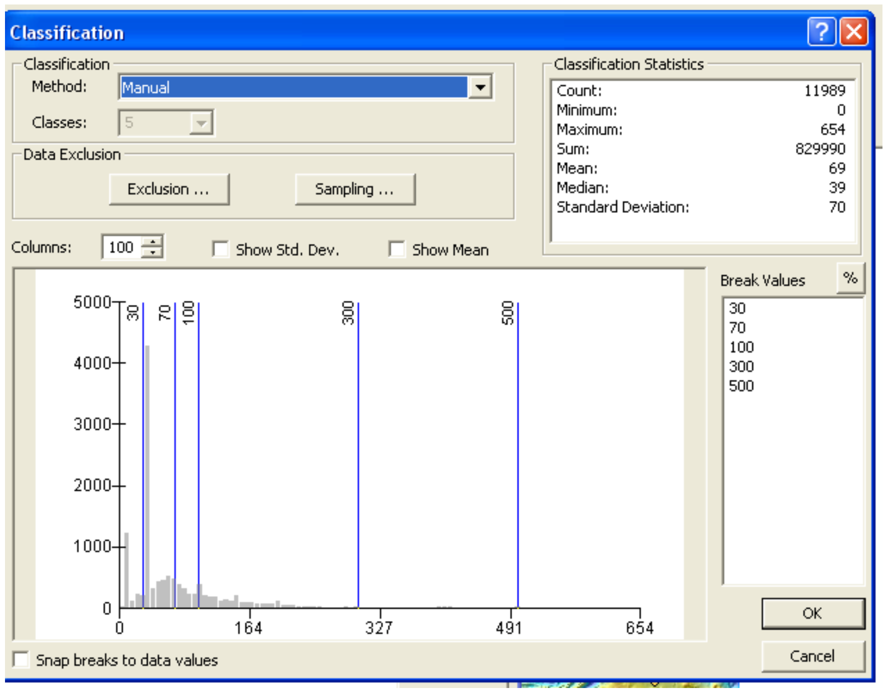


Figure 10: ArcMap showing the representation of volcanoes in the area as the dark red clusters. DEM and Hillshade of Woodlark Basin region is distinguished with Spectrum Full Bright color ramp; other DEMs are less accented to emphasize volcanic activity

b. As with the World volcanoes Excel to ArcMap procedure above, repeat for earthquake data.

1. Chose to symbolize earthquake data by depth in order to visualize subducting plate movement. "Symbology>Quantities" and choose Depth for the Value Field. Modify maximum sample size to one that is larger than the total number of earthquakes and then change the break values of the data to five increments at 30, 70, 100, 300, and 500. **Refer to Figure 11 below.**



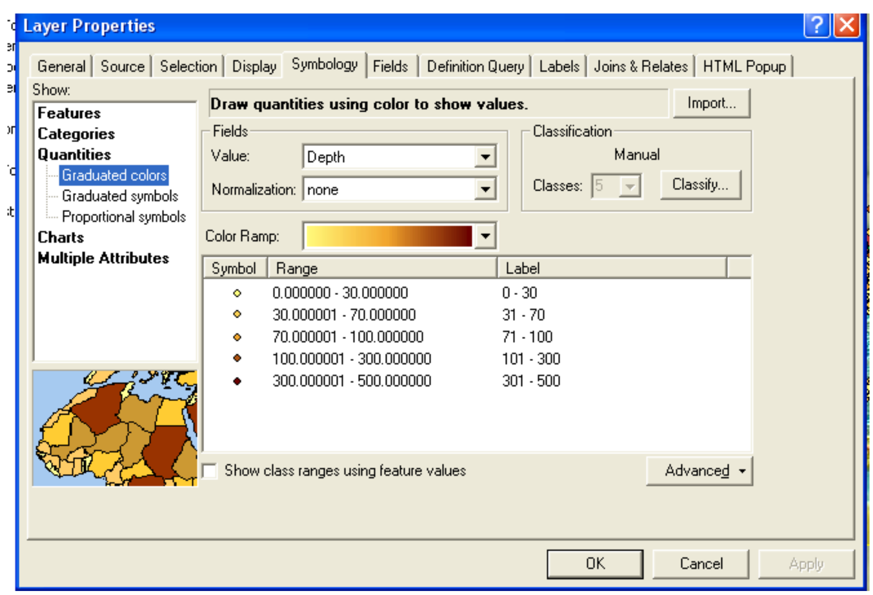


Figure 11: Top: Classification window modified to Manually break values, inserted in lower right corner; Bottom: Layer Properties window of the earthquakes layer in ArcMap showing color ramp association with earthquake depth which is viewed on the map in **Figure 13**

7) Georeferencing the JPEG files

a. Open up a new ArcMap at set the DataFrame to WGS84; add the Wood_ages jpeg. Add the Georeferencing Toolbar, set the target layer appropriately and click on View Link Table to Add Control Points. Add control points for all four corners of the jpeg by entering coordinates of desired clipping area (coordinates labeled on jpegs) by Input XY. Make sure there is a low residual and then select Update Georeferencing. Use the Clip tool to clip the raster and get rid of the map border. Repeat with additional jpeg **(Figure 12).** Once both jpegs are georeferenced, add them to the Woodlark ArcMap and hide all white color in the ages jpeg by checking the Display Background Color box, modifying all three boxes to 255 (white), and then choosing No Color. To hide color for the vectors jpeg go to the Symbology tab, click classified, and change the white to No Color.

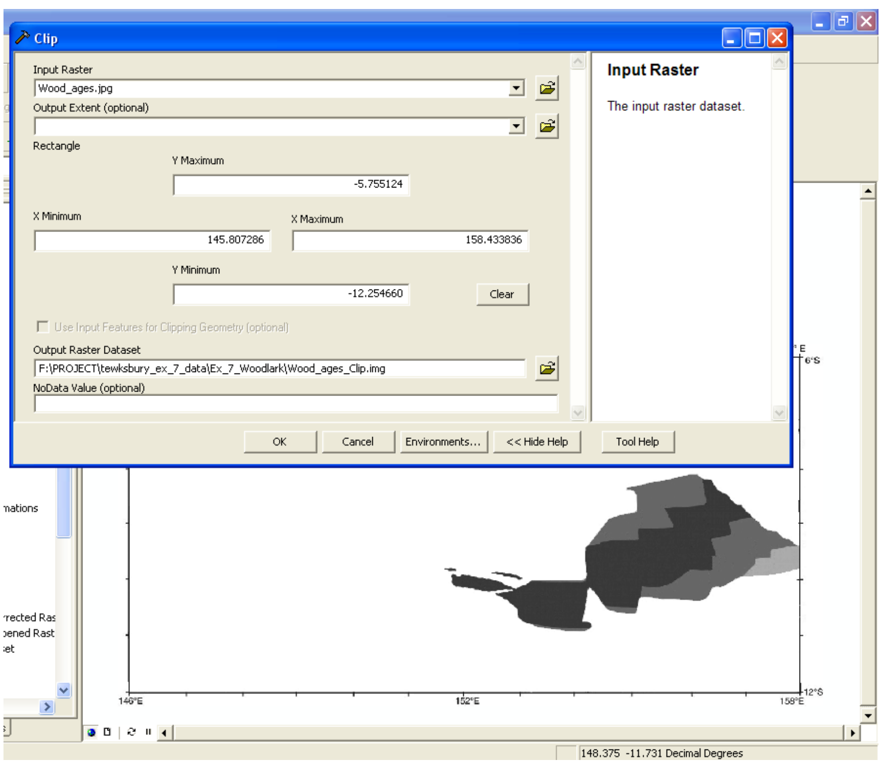


Figure 12: Clipping the georeferenced JPEG image to get rid of border containing Latitude and Longitude

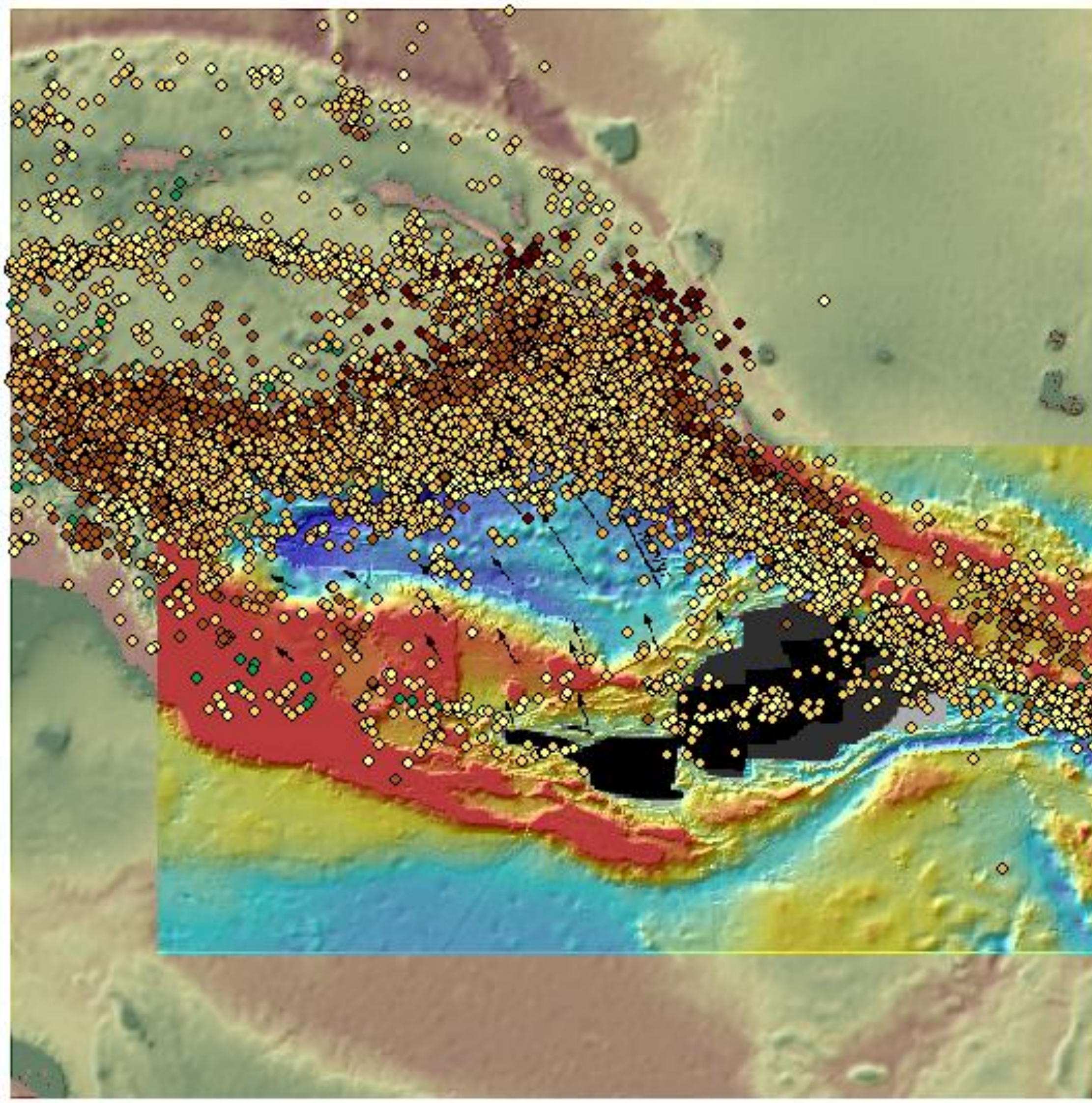
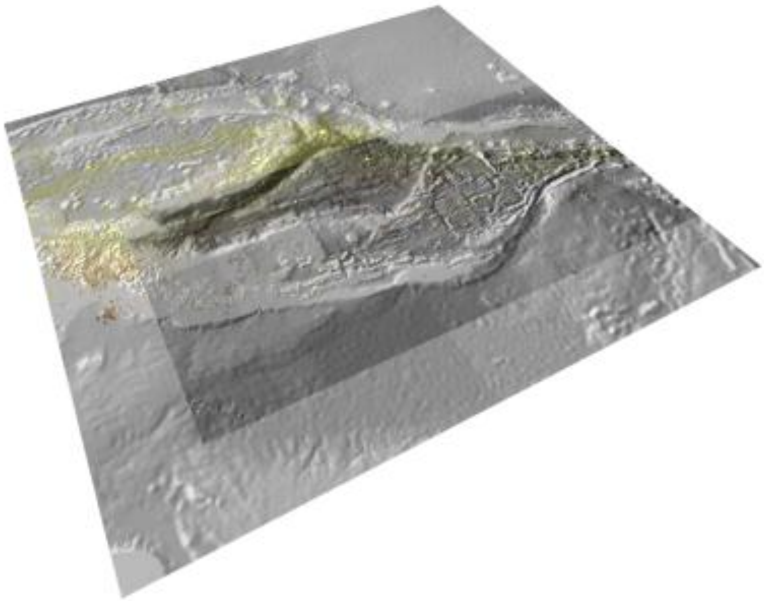


Figure 13: Image showing clipped earthquake layer reclassified by depth, georeferenced and color corrected vectors showing direction of movement and velocity, and georeferenced Woodlark oceanic crustal ages (Dark gray = <2 Ma, Medium gray = 2-4 Ma, Light gray = >4 Ma)

8) The earthquakes can be viewed more realistically to determine subducting plate margins by using ArcScene. Right now, the earthquakes are plotted as if they were surface quakes. ArcScene will plot them at their correct focal depths.

a. Open ArcScene, add your earthquake layer, and select Base Heights tab from the Properties window. In our current dataset, X and Y are in decimal degrees but Z is in kilometers and all of the numbers are positive. In the Base Heights box enter the constant expression [Depth]*-.00912 where -.00912 is the Z factor which converts the depth from kilometers to decimal degrees and changes the sign to negative because it is below sea level. Add the etopo1 hillshades and change the z factor. **See Figure 14 below.**



North South

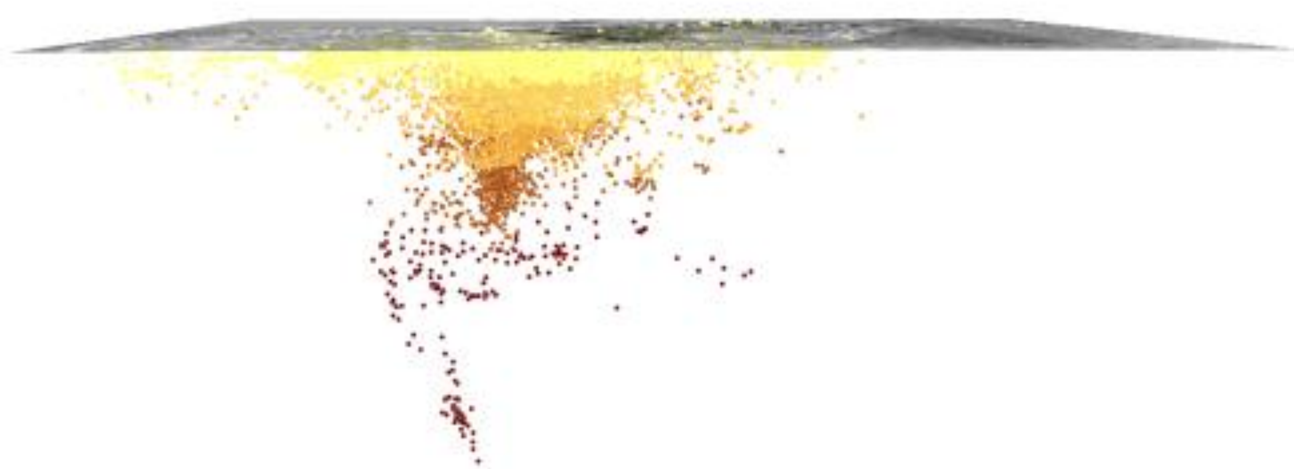


Figure 14: Top: Transparent view of Woodlark Basin region – earthquake foci trend toward the North; Bottom: 3-D view of eartquake depths near Woodlark Basin region using ArcScene

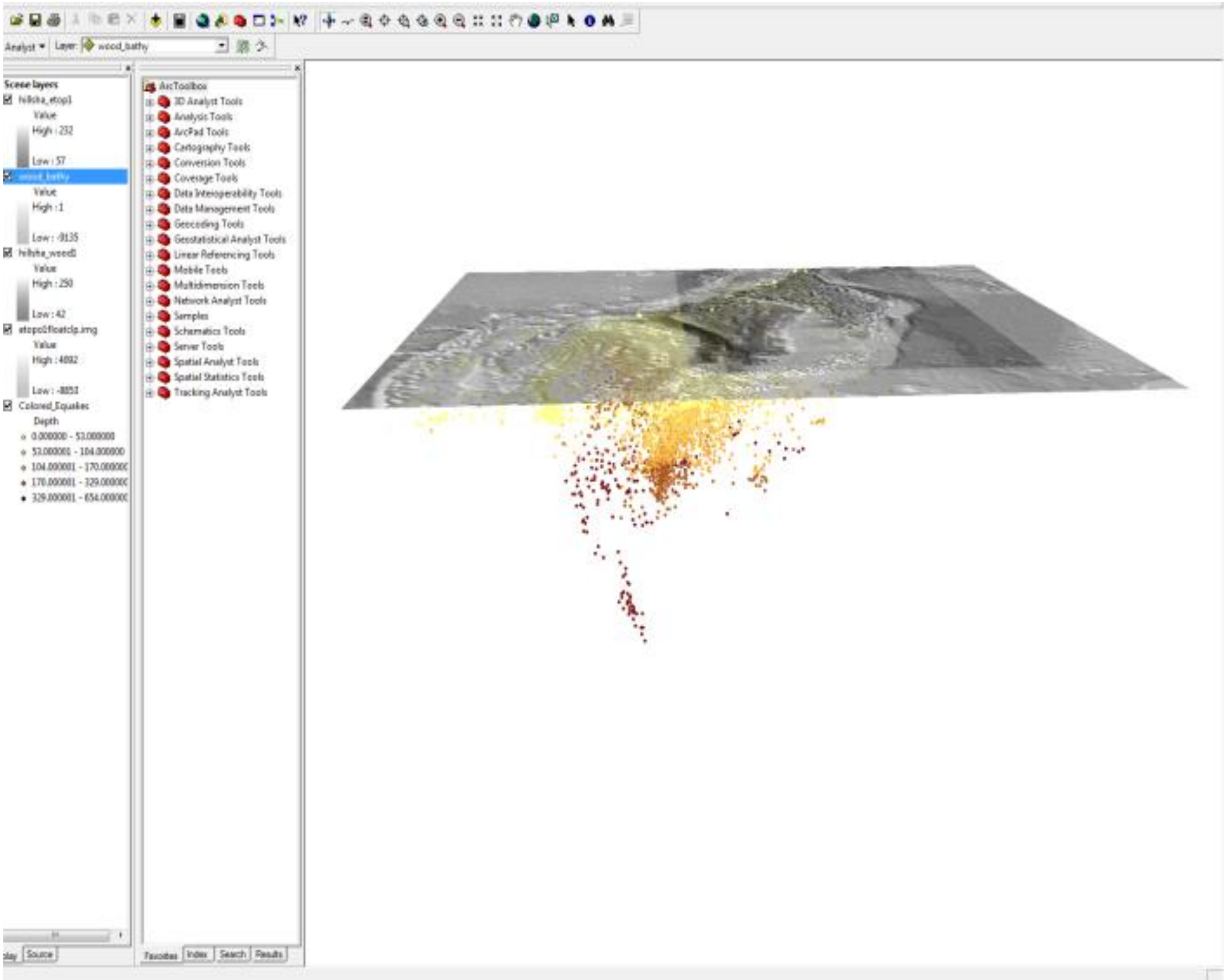


Figure 14 Continued: Another view of transparent bathymetry and earthquake focus depths using ArcScene

9) Now that all of the data has been properly converted, mosaicked, and hillshaded, we are able to combine our knowledge of GIS with the geologic evidence presented through the bathymetry, earthquake data, and volcanic data to determine where plate boundaries for the Woodlark Basin exist.

a. Open ArcCatalog and create a new polyline shapefile with the same coordinate system as the other files in our Woodlark Map. Add a new field to the attribute table before editing, "Properties>Fields" tab and type in boundary under Field Name, assigning it to a Text Data Type and a field length of 30 **(Figure 15)**

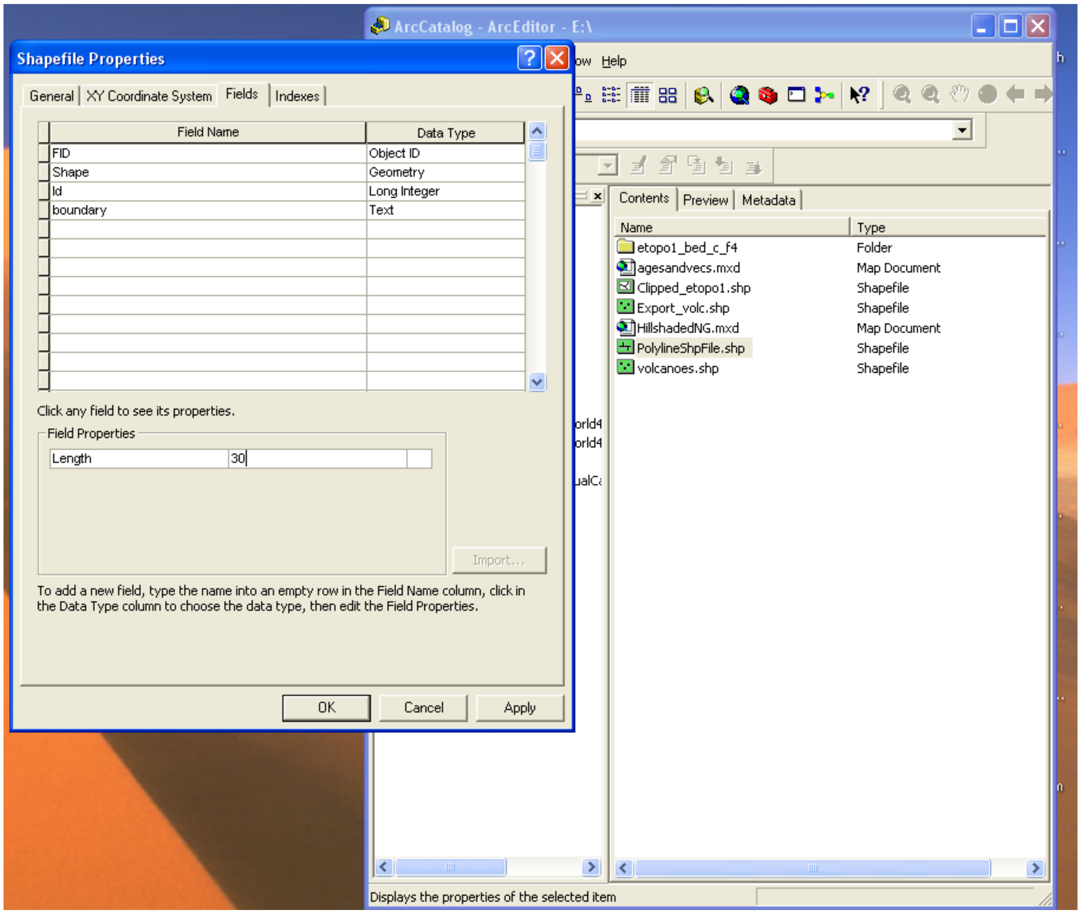


Figure 15: Creating a new polyline shapefile titled "boundary" in ArcCatalog; shapefile will be used to digitize separate georeferenced lines as plate boundary types

b. Add the new shapefile to the Woodlark Basin Arcmap and turn the Editor Toolbar on to start editing; set the snapping. Select Create New Feature with the correct target shapefile selected, and click on the pencil tool to start drawing interpretations of plate boundary locations. **Figure 16** shows needed requirements. "Finish Sketch" when done with a line, and then type the name of the boundary type in the value field next to the "boundary" property in the attributes icon on the editor toolbar. **Figure 17** displays polyline and attribute icon table below.

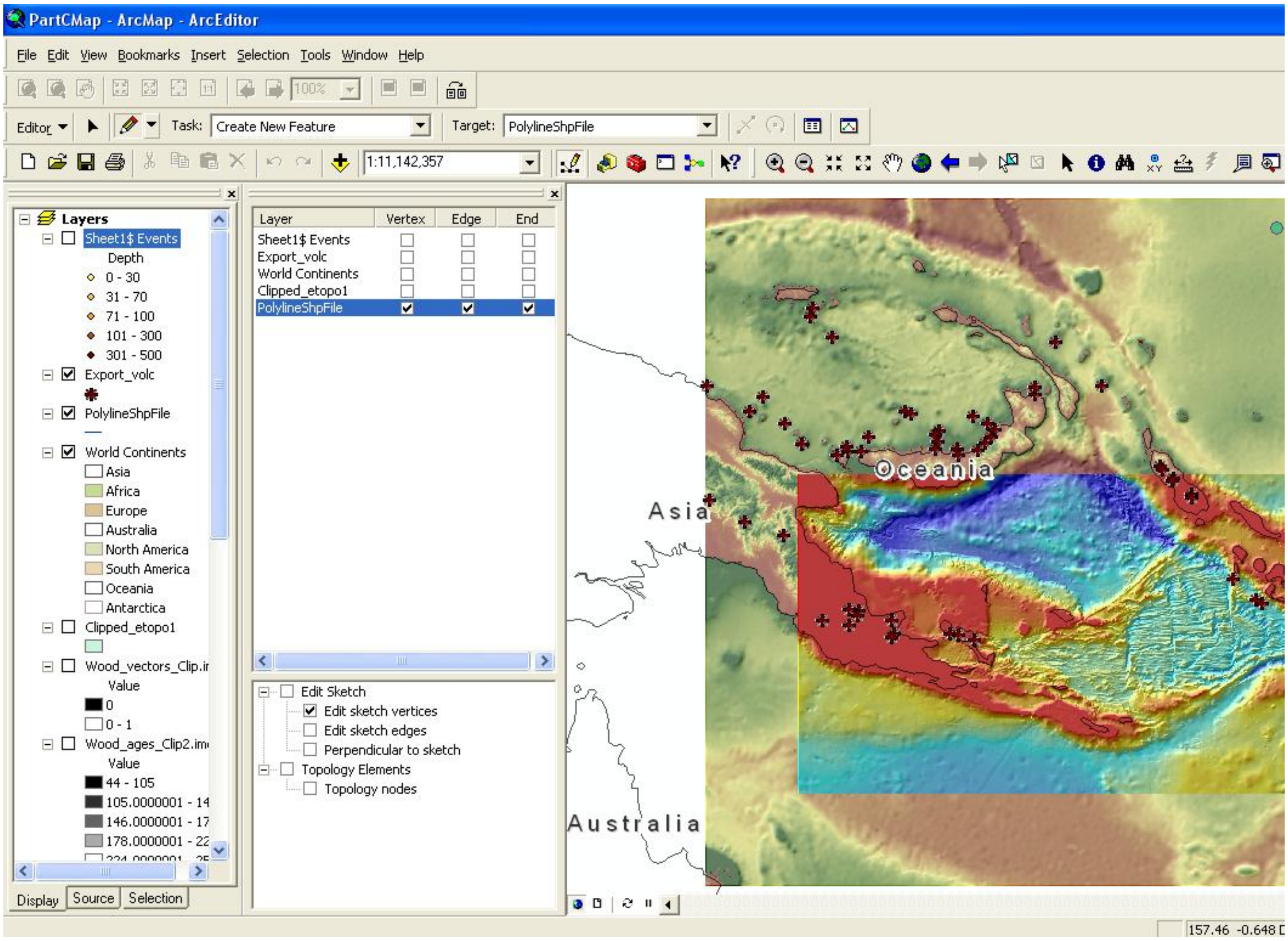


Figure 16: Using the Editor Toolbar in ArcMap to "Create New Feature" with Pencil tool in the selected target that is a polyline shapefile; snapping is set for target layer

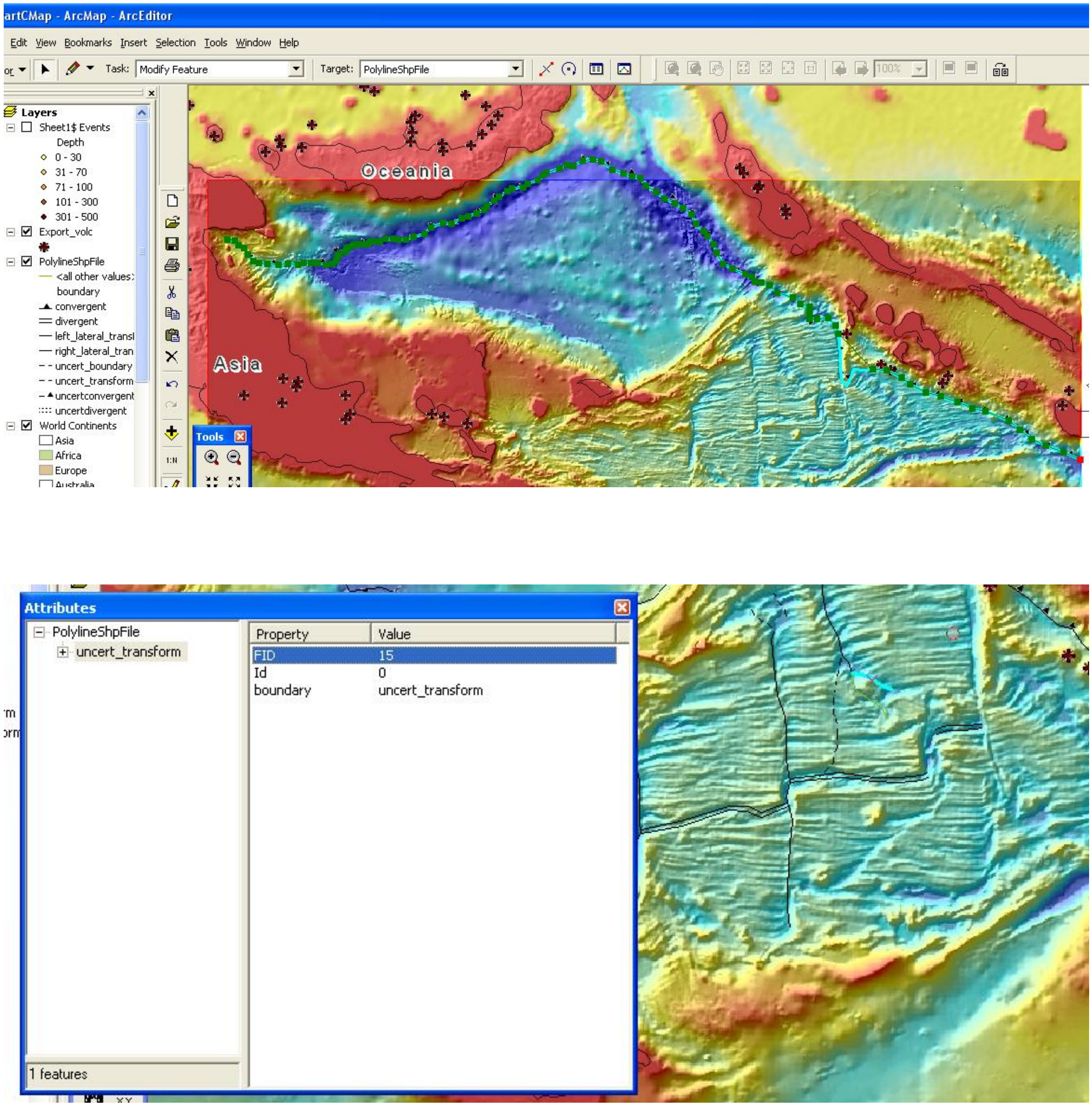


Figure 17: Top: Green line represents polyline feature created by the Pencil tool in the Editor Toolbar in ArcMap. The green dots are named vertex and the red dot on the far right is the "end"; Bottom: Attribute table shown from the Attribute Icon in the Editor Toolbar for an "uncertain transform" fault boundary

c. The values added in the Attribute Icon table can be symbolized by going to "Symbology>Catagories>Unique Values" and then choosing "boundary" in the Value Field and "add all values". This will list all values entered while editing in the Editor Toolbar. By clicking on Geolgy 24K in the More Symbols button, you are able to designate the appropriate fault symbols with their appropriate names. **Figure 18** displays the appropriate fault symbology for the region.

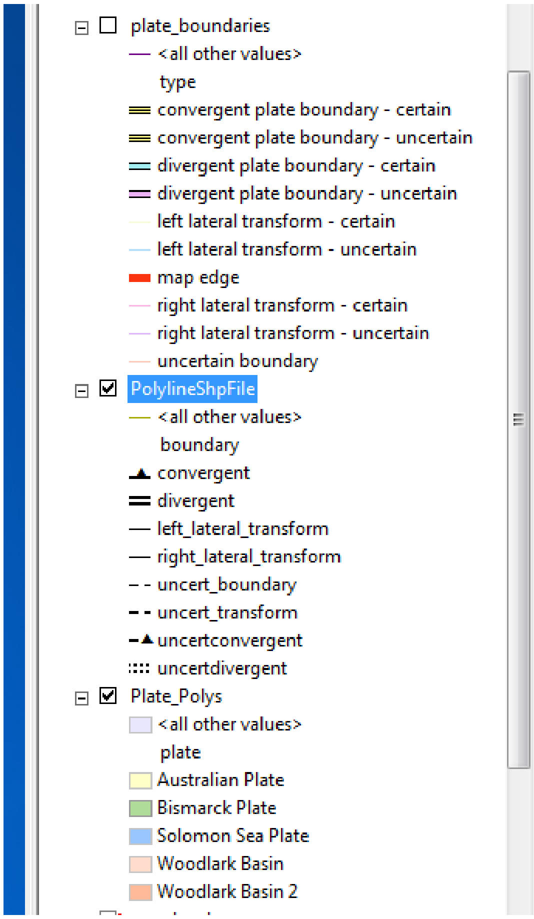


Figure 18: Highlighted "PolylineShpFile" represents the appropriate symbology for the different plate boundaries within the area

d. Continue labeling the different polylines while digitizing in all possible plate boundaries in the area. **Figure 19** contains two images, one showing more detail, of my interpretation on where the plate boundaries and faults exist within the Woodlark Basin

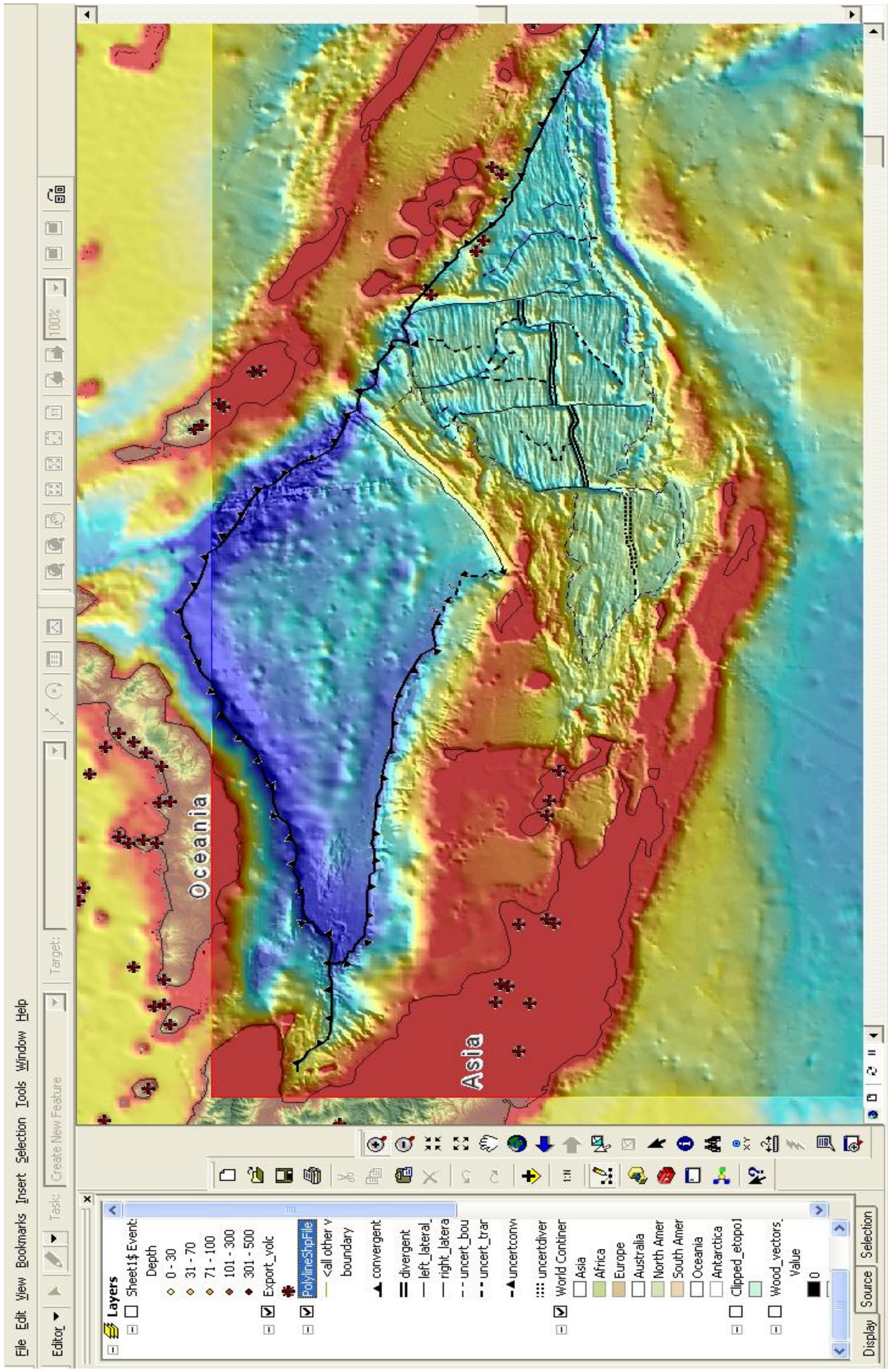


Figure 19: Digitization in ArcMap using polylines to create first interpretation of plate boundaries and faults in the Woodlark Basin region

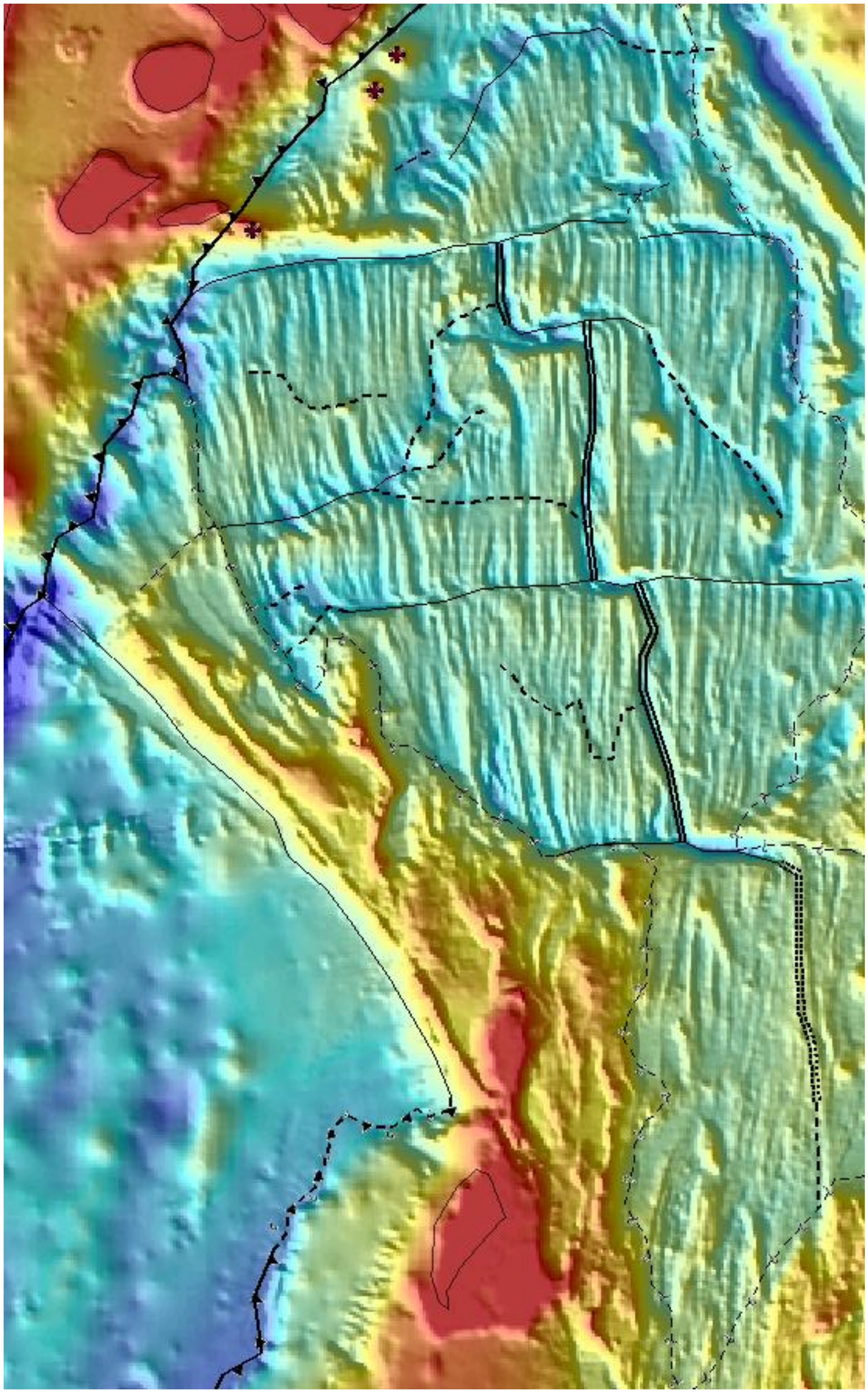


Figure 19: Zoomed in portion showing digitization of plate boundaries and faults in the region. Arrows point in direction of subduction for convergent faults

10) Now that we have interpreted the elevations, earthquake data, and volcanoes to determine plate and fault locations, we need to create a geologic map by converting the lines to polygons using a Geodatabase and topology.

a. In ArcCatalog create a new Personal Geodatabase and name the database Woodlark_Geodatabase. Inside the geodatabase add a Feature Dataset with the GCS_WGS_84 coordinate system. Within that Feature Dataset, add a new Feature Class selecting Line Features **(Figure 20)**. Under Field Name, add a new field called type under the word SHAPE, with the Data Type to text. Do not allow any NULL values, and click Finish. We also need to add Domains for the Geodatabase: Click Domains tab, enter bound_types under Domain Name, and change the Field Type to Text. Under code description, type in the different types of plate boundary lines for the Woodlark Basin:

divergent plate boundary – certain
divergent plate boundary – uncertain
convergent plate boundary – certain
convergent plate boundary – uncertain
right lateral transform – certain
right lateral transform – uncertain
left lateral transform – certain
left lateral transform – uncertain
uncertain boundary
map edge

Under Properties for the Plate_boundaries feature class, click Fields, highlight type, and click next to Domain to select bound_type list. These are the only boundaries we will be able to chose when we are in ArcMap

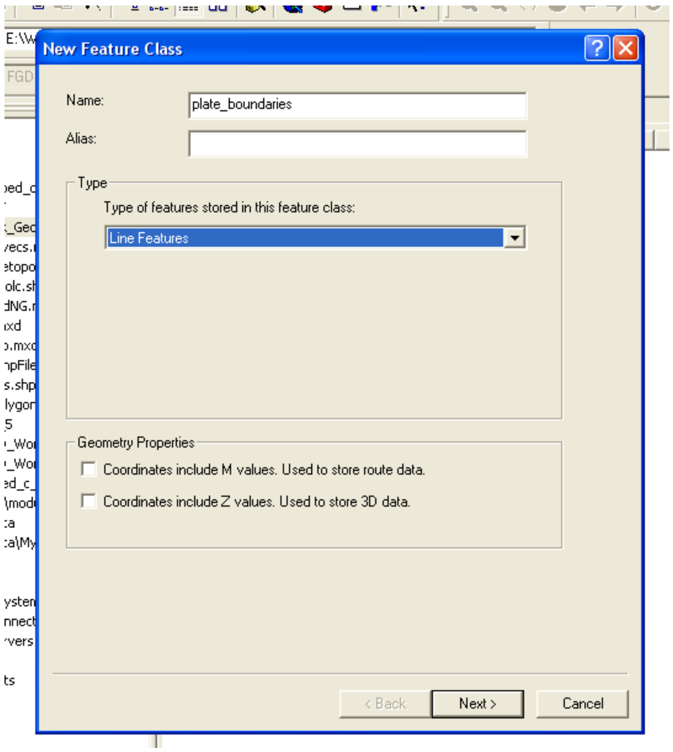


Figure 20: Creating a New Feature Class with a "Line Features" type within a Feature Dataset

11) Before we start digitizing our line feature class, which will later generate polygons, we need to set the topology in ArcCatalog. In the Feature Dataset choose New> Topology

a. Add "must not have dangles"

b. Add "must not self intersect" **(Figure 21)**

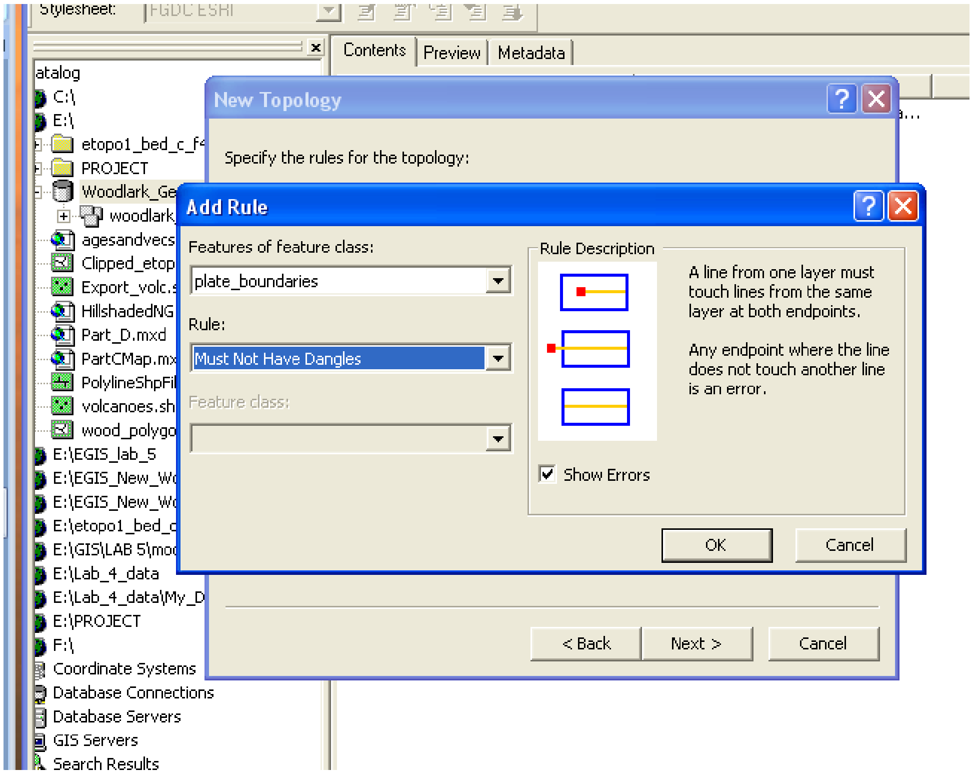


Figure 21: Adding topology rules in ArcCatalog

12) In the Woodlark Basin ArcMap add the plate_boundaries Feature Class to the map and start editing with the Editor Toolbar. Set the snapping and the snapping tolerance, and then procede to create a box at the perimeter of the map area by setting a vertex at each corner. Choose "Finish Sketch" and then choose "type" as "map edge" **(Figure 22)**. Procede to snap the new plate_boundaries to the existing polylines for accuracy.

a. Once done snapping the new feature class to the existing polylines, test for violations of the topography rules by closing ArcMap, and opening ArcCatalog. Right click the topology layer and click on validate: screen should be clear in preview if no topology errors are made.

b. Now, we can finally create our tectonic plates! In ArcCatalog choose "Polygon Feature Class from Line" in your Woodlark Feature Dataset and perform new polygon feature class. Add new polygon feature class to the Woodlark Basin ArcMap, and add domains and symbolize using steps as mentioned before.

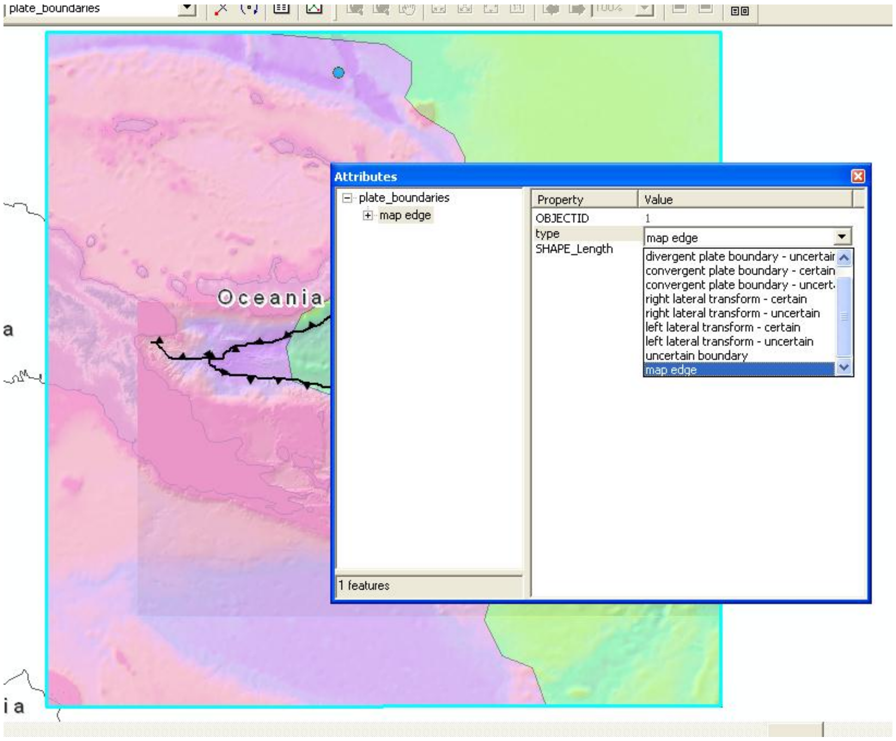


Figure 22: Digitizing a perimeter around area of interest and using the Attribute Icon to select Plate_boundary type

13) After evaluating the regional bathymetry, topography, 3-D earthquake depth models, seafloor ages, plate motion vectors, and plate boundary types, I was able to construct a final map showing what I interpreted as the plate boundaries of the complex region known as the Woodlark Basin. No outside sources were visited in order to determine interpretation of plate locations, but only queried for the names of the surrounding plates. The Woodlark Basin is comprised of the two different shades of red, with a divergent plate boundary through the center and multiple transform faults (mostly left lateral) in the interior. The westernmost boundary of the Woodlark Basin is the most uncertain boundary drawn on the map; interpretations were based on the DEM data and the western extent of the plate boundary is somewhat ambiguous from the information. The divergent plate boundary within the Woodlark Basin could possibly cut westward across the landmass and continue as some sort of plate boundary where the bathymetry is visibly deeper (**Figure 24**). The earthquake data presented previously did not support a subducting plate boundary between the Australian Plate and/or the Woodlark Plate/Solomon Sea Plate. The alternative, uncertain boundary type could be drawn (**Figure 24**), toward the Northwest, but additional research would be required to determine the correct plate name. **See Figure 23 and 24 below, with final maps attached.**

Additional calculations:

Estimated Total Area of Tectonic Plates

-GCS would not allow areas or lengths to be calculated, so used the Project tool within "Arctoolbox>Data Management Tools> Projections and Transformations" to project the layer to Mercator

-Add new field to Attributes of newly projected layer and calculate areas of interpreted plates

Plate	Area (Squared Miles)
Woodlark (north side)	33174
Woodlark (south side)	33408
Solomon Sea Plate	48360

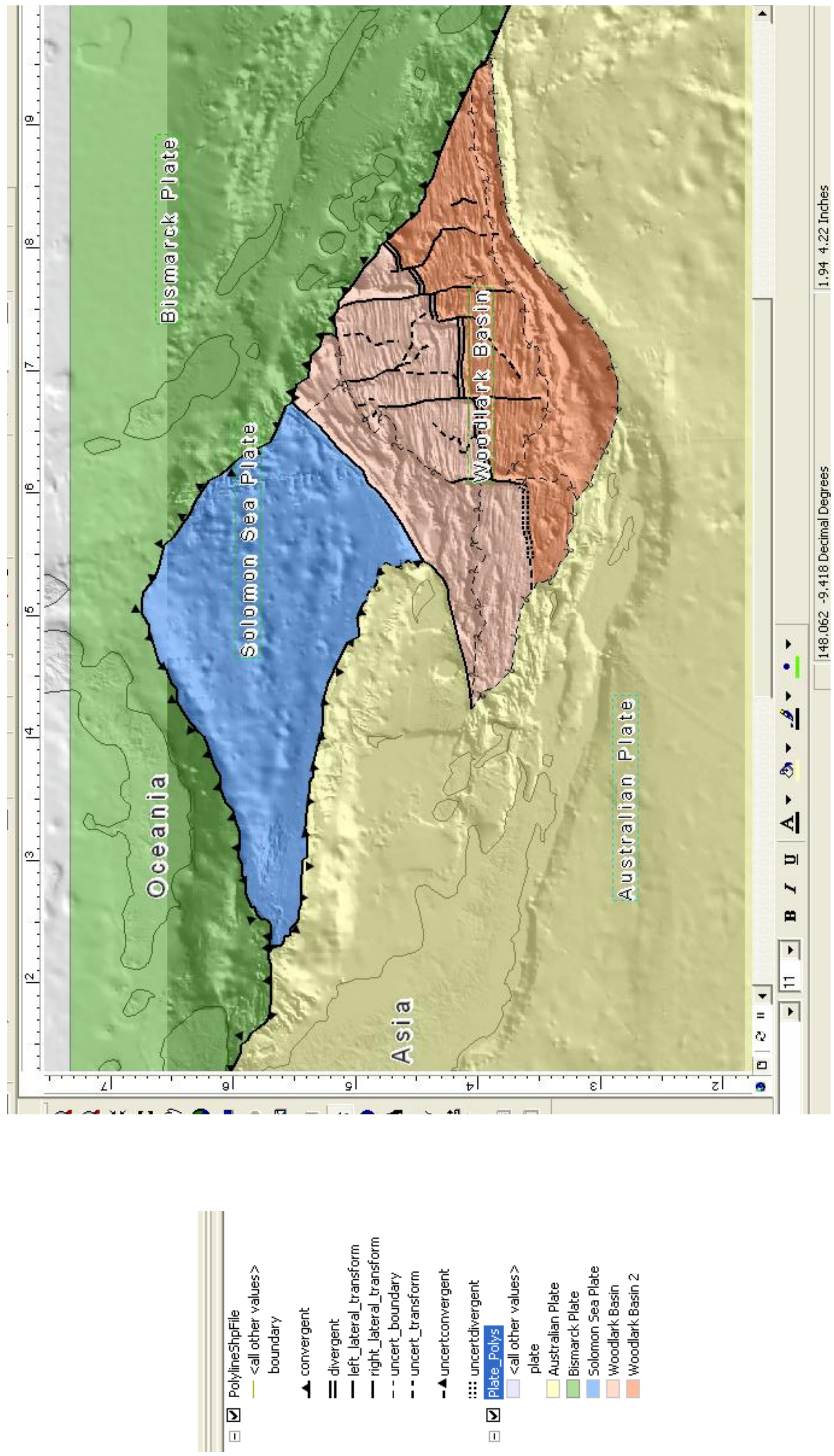


Figure 23 is comprised of the new polygon feature class determined by polyline digitization of local fault and plate boundary interpretations, and is underlain by the dynamic hillshade layers from three different DEM sources.

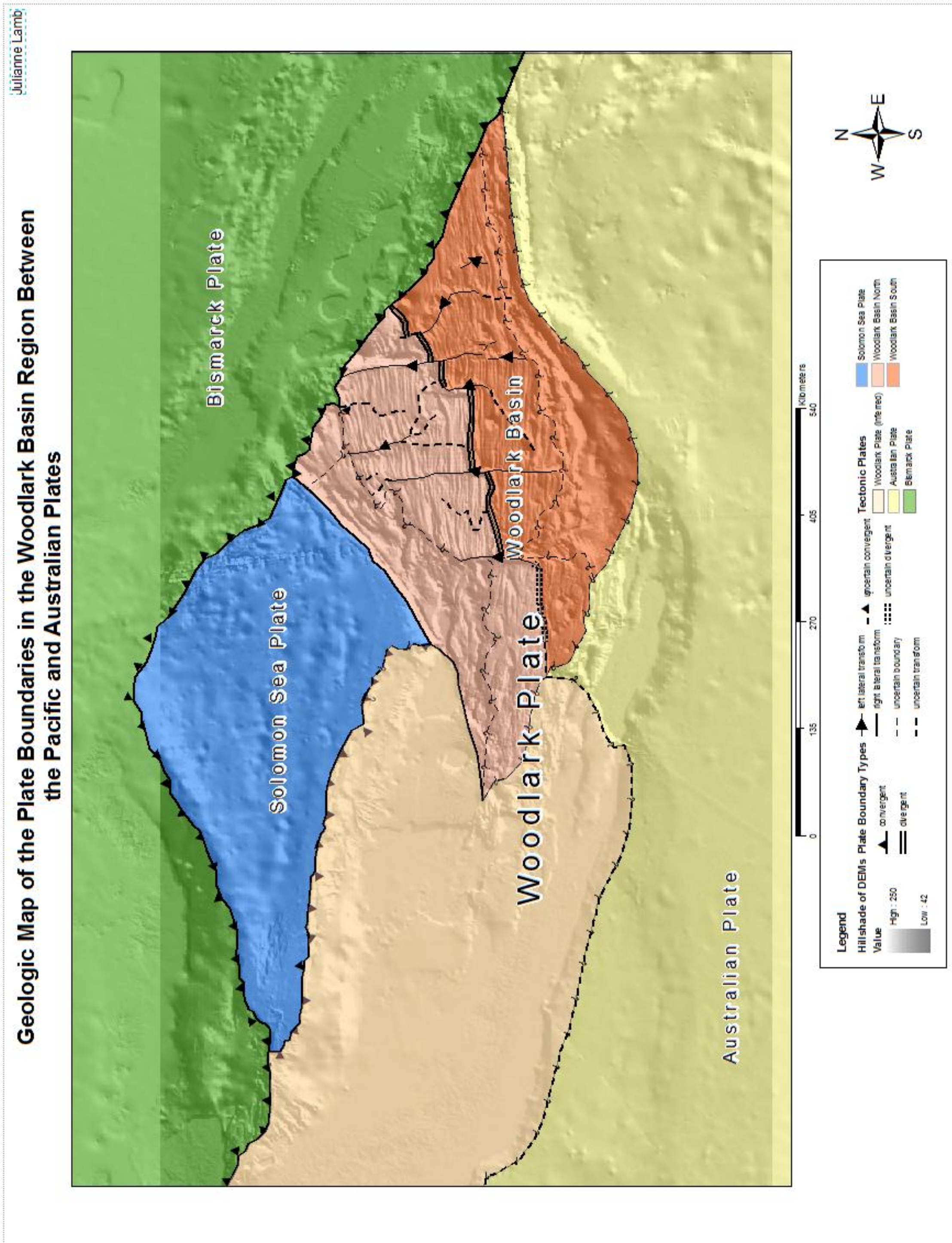


Figure 24: Screen shot of final map showing the interpreted tectonic plates of the Woodlark Basin region