

## Mapping Geologic Data with GIS

There are several ways to learn about GIS. ESRI, a leading GIS software developer offers a series of online lessons that can be used to learn about how GIS can be used to view and map geologic hazards. These lessons are available at: <http://learn.ArcMap.com/en/>. Among the lessons that might be of interest are:

- [Mapping Volcano and other Data in Hawai'i with ArcMap Enterprise](#)
- [Find Areas at Risk of Flooding in a Cloudburst](#)

There are also other lessons on topics that are not related to GIS, so you might want to explore the site to find other lessons of interest.

It is also possible to explore GIS by using online mapping systems to explore data and procedures with GIS. Among the sites that could be used are:

- [IndianaMAP](#)
- [Ecosystems](#)
- [Exploring Environmental Justice using EJ Screen from the Environmental Protection Agency](#)
- [National Oceanic & Atmospheric Administration Sea Level Rise Viewer](#).
- [Protected Areas Viewer](#) – to view protected land areas in the United States.

### Exploring Data and Combining Data Sets in Online in EJScreen

1. Connect to the Environmental Protection Agency's [EJScreen](#) website and click on [Launch EJScreen Tool](#).
2. Enter a place name to view a map of a specific location. Explore the various types of hazards in the area by clicking on **Add Maps**.
3. Choose **EJScreen Maps**. A box will open on the left side of the page showing the various types of environmental hazards. Choose a data **Category, Variable** and then click **Add to Map**. Data for that variable will be mapped. After exploring the various data categories, click X to close out the EJScreen Maps.
4. Choose **Add Maps** and then **Additional Maps**. Choose **EJScreen Environmental Sites and Sites Reporting to EPA**. Click in the check boxes to turn the various types of sites off and on.
5. Choose **Add Maps** and then **More Demographics**. Explore the various demographic data available in EJScreen. Note that it is also possible to vary the colors used to map the data, the method of classifying the data and the number of breaks. Choose a population category, variable, and color and then click **Add to Map**.
6. Click on **Add Maps, Search for Maps** and then **Add Map Services**.
7. Add the URL to the map service of interest, such as the PAD-US WMS: [https://gis1.usgs.gov/ArcMap/rest/services/PADUS1\\_4/Fee\\_Protected\\_Green/MapServer](https://gis1.usgs.gov/ArcMap/rest/services/PADUS1_4/Fee_Protected_Green/MapServer) and then click Add to Map. The protected land areas and parks in the region of interest will be shown.

## Exploring Geologic Data from IndianaMAP

1. Link to [IndianaMAP](#) and click on View the Map. When the map site loads, a map showing interstates and county boundaries will be shown.
2. Click on Layer Gallery on the upper right side of the page. The layers are organized by theme, including Demographics, Government, Infrastructure, Environment, Hydrology, Reference, Geology and Imagery.
3. Click on a general theme to see the data available in that theme. When a theme, such as **Liquefaction Potential** (under **Seismic**) is found, click on **Add Layer**. It is also possible to add more than one layer. For example, adding Quaternary Geology allows you to some simple analysis. To view the map, click on the words **Map Viewer**. The layer(s) chosen will be shown. It is possible to move layers up and down in the active layers area by clicking on the arrow next to the layer name.



4. Click on the **Legend** button at the top right side of the page. The legend for the map shown will appear. Close the layer by clicking on the X in the upper right side of the window.
5. If you loaded both the Earthquake Liquefaction and the Quaternary Geology, experiment with the slide bar on the top layer. Do you notice any similarities between the Quaternary Geology and the Earthquake Liquefaction potential? Explore some of the other categories of data. Think of some questions that could be asked and answered using the online GIS system. An example might be what types of units have a high radon hazard?

## Mapping Data with ArcMap

This set of exercises will introduce mapping data with GIS software installed on a computer. All GIS Data is in the **GIS Data** folder on the Flash Drive. The Flash Drive comes with several different data sets, including data on World Gold Production by country (**Gold.dbf**), the locations of volcanoes (**Volcano.dbf**) and major meteorite impacts (**Impacts.dbf**) in the World, data on United States coal production (**Coal.dbf**) and U.S. Geology data (Glacial, Faults, and USGeology). It also comes with the geographic boundary data needed to make a map. These exercises can be done at different times. When you decide to stop, just exit **ArcMap** without saving the exercise. When you start another part of the exercise, simply add the data for that part by following the steps in sections A1 to A3.

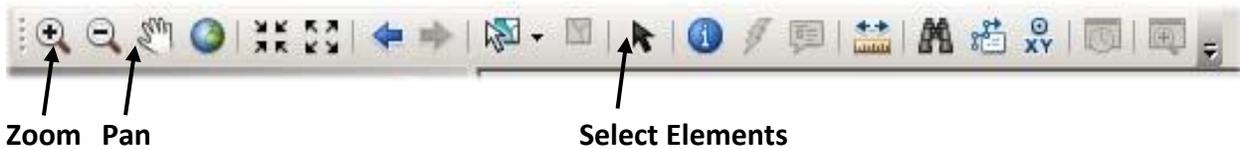
## Instructions for getting ArcMap Version 10.x for Desktop Student Trial Software

1. Before you install ArcMap for Desktop check the [ESRI System Requirements](#) to make sure your computer meets the standards for hardware and software.
2. Link to the [ESRI Free Trial](#) website. The trial allows users a license for 21 days. Sign up for a trial and follow the instructions provided to load the software.

## Part A. Working with ArcMap

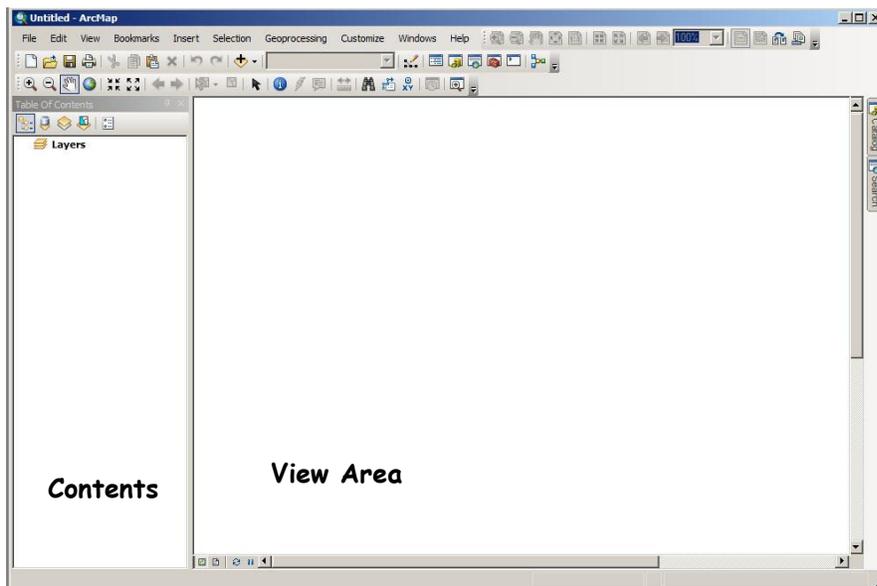
A1. Start **ArcMap** by clicking on **Programs, ArcMap** and then **ArcMap**. The **ArcMap** icon looks like this: . Wait until **ArcMap** loads. The program will ask whether you want to start using ArcMap with a new empty map, a template or an existing map. Choose **Existing Maps** and then **Browse for More**. Connect to the flash drive on your computer and select **WorldCities.mxd**. A map showing the countries and major cities of the World will open.

A2. The **ArcMap Toolbar** may be in a separate window. Use the mouse to drag them to the top of the **ArcMap** window and maximize the program so that it takes up the entire screen. The important tools on the ArcMap toolbar are shown below.



The **Zoom** button is used to increase the scale of the map. The **Pan** button (looks like a hand) is used to move a map around in the view area. The **Select Elements** button is used to point at and click on a feature. Keep the Select Features button chosen unless you want to pan or zoom.

Note the areas identified in the graphic below. From now on, the instructions will refer to the **Contents** area and the **View** area.



A3. Click on the **Zoom**

button . Use the mouse to draw a box around part of the map in the view area. The outlined area will increase in size.

A4. Click on the **Identify**

tool . A window will open asking you to choose the data set to identify. Click on **Cities**. Use the mouse to click on

one of the cities on the map (the cities are shown as a dot). A window will open showing information about that city.

A5. Experiment with the other tools on the toolbar, such as the hand (which allows you to move

the map around on the screen), the **Full Extent**  and the **Previous Extent**  buttons. Then exit ArcMap by choosing **File** and then **Exit**.

## Part B. Getting Geographic Data into ArcMap

B1. Start **ArcMap** by clicking on **Programs, ArcMap** and then **ArcMap**. The menu provides the option to open an existing map or a new map. Click on **New Maps** and then click on **Blank Map**.

B2. Drag the **ArcMap Tools** to the top of the **ArcMap** window and maximize the program so that it takes up the entire screen.

B3. Click on the **Add Data** button . The **Add Data** menu will appear. Use the **Connect**

**to Folder** button  and connect to the Flash Drive. Open the **GIS Data** folder.

Add the data named **World\_Adm** and **World\_Grid**. Look in the Contents area. If the **World\_Grid** data is on the top, click on it and drag it to the bottom of the list while holding the left mouse button down. If the layer will not move, click on the buttons underneath the words **Table of Contents**. These buttons allow the user to adjust the list order.

B4. Use the mouse to double click on the **World\_Adm** data in the contents area. Then click on the **Symbology** tab. Click on the raised box in the symbol area. The **Symbol Selector** will open. Click on the **Fill Color** button on the right side of the menu. Change the fill color in the **World\_Adm** data to white and the outline color to black. Then click **OK** (twice). The color of the countries will change to white. Repeat these steps with the **World\_Grid** data. Set the fill color to Blue and choose another blue for the outline. The country area on the map will now be white with black boundaries and the oceans will be blue.

## Part C. Joining Attribute Data to Geographic Data

The **World\_Adm** data does not contain a lot of information. If you right click on the **World\_Adm** data in the in the contents menu and highlight the words **Open Attribute Table**, you will see that the table contains a feature ID code, the type of data (polygon), the Country name, World region and the FIPS (Federal Information Processing System) codes for the country. During this exercise you will be adding data for World gold production from 2001-2005. Attribute data is numeric or text data that describes the characteristics of a geographic area. The attribute data for this exercise must be joined to the boundary data for **World\_Adm**.

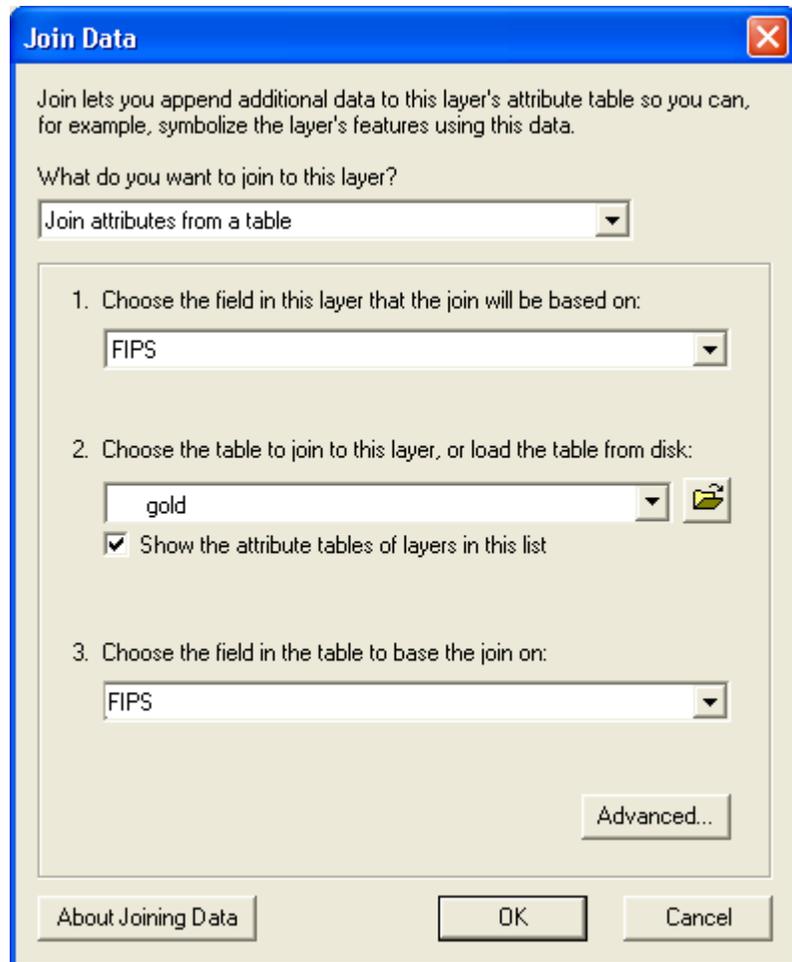
C1. Close the Attribute table for the **World\_Adm** data by clicking on the close file button in the upper right-hand corner of the table (the **White X**).

C2. Right click on the **World\_Adm** data and, while still holding the right mouse button down, highlight the words **Joins and Relates** on the menu that appears. Select the **Join** option. The **Join Data** menu will appear.

C3. The menu asks you to choose the field in this layer that the join will be based on. Select **FIPS** (the country FIPS code).

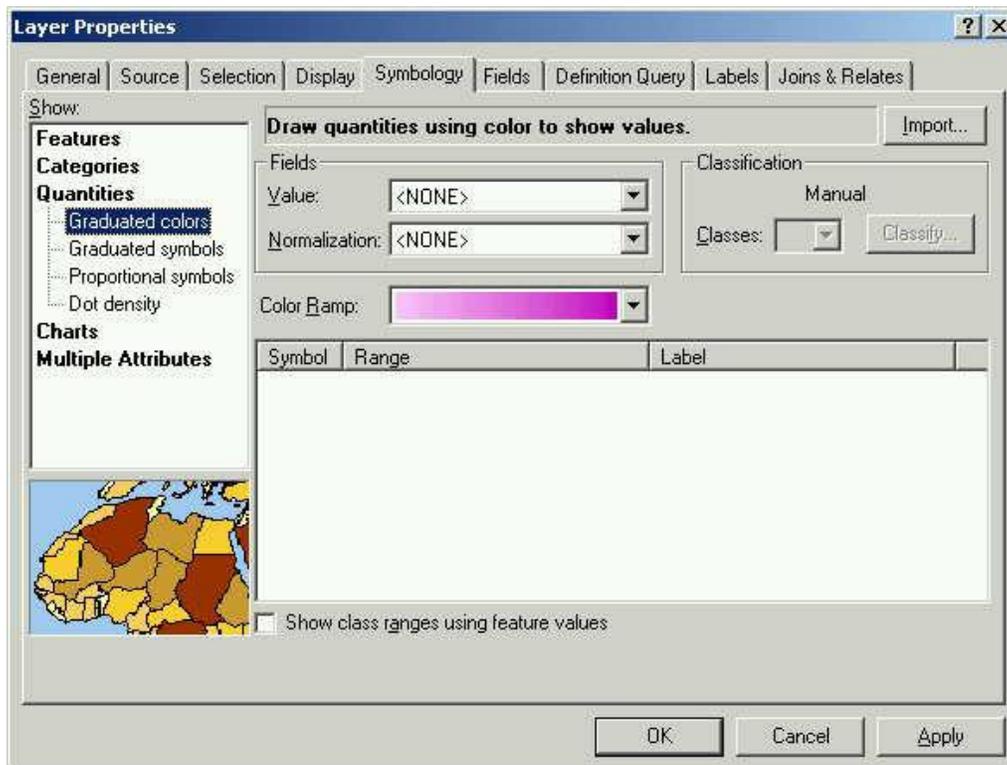
C4. The next item in the menu asks you to **choose the table to join to this layer or load the table from a disk**. Click on the **Folder** button to connect to the Flash Drive drive and choose the **Gold.dbf** file. Click on the **Add** button; the menu will close and you will see the word **Gold** in the second box.

C5. The **Join Data** menu will then ask you to **choose the field in the table on which the join will be based**. Choose the **FIPS** field and click the **OK** button. If you open the attribute table now, you will see that it contains data for gold production from 2001 to 2010.



## Part D. Mapping Gold Production

D1. Double click on the **World\_Adm** data. The **Layer Properties** menu will appear. Choose the **Symbology** tab if it does not already show in the **Layer Properties** menu.



D2. In the **Show** box at the left side of the **Symbology** menu, click on the word **Quantities** and choose **Graduated Colors**. This option allows you to create a map using color to show ranges of data. The **Fields** box lets you choose the value that will be mapped. Use the pull-down menu next to the word **Value** to choose **P\_2001**. Use the pull-down on the color ramp to choose the color scheme for a map (use a scheme with only **one color family** not a multi-colored scheme [yellow to blue]). Click on the first set of numbers under the word **Range** and change the second number to 0 (zero). Then click in the box to the left and set the color to white. This way the countries that did not produce any gold or those that did not have any data will not be colored. While the **Layer Properties** box is still open, click on the first number in the second row of numbers and change it to 1. Click **OK**. The map shows the amount of gold is produced in a country by a range of colors. Try changing the year in the **Value** box to see if the map changes at all.

D3. Double click on the **World\_Adm** layer again. Now select **Charts** in the **Show:** area. Then select **Bar/Column**. In the **Field Selection** area, choose **P\_2001**, **P\_2003** and **P\_2005** while holding down the **Control** key. As the field selections are made, the right arrow button will become active. After making the selections, click on the right arrow button. The three field selections will now appear in the right hand box. Double click each year and pick colors that you would like to use on a bar chart. Then click **OK**. You will see that the gold production is now

shown as a bar chart rather than by color. Are there any countries that had an increase in Gold production from 2001 to 2005?

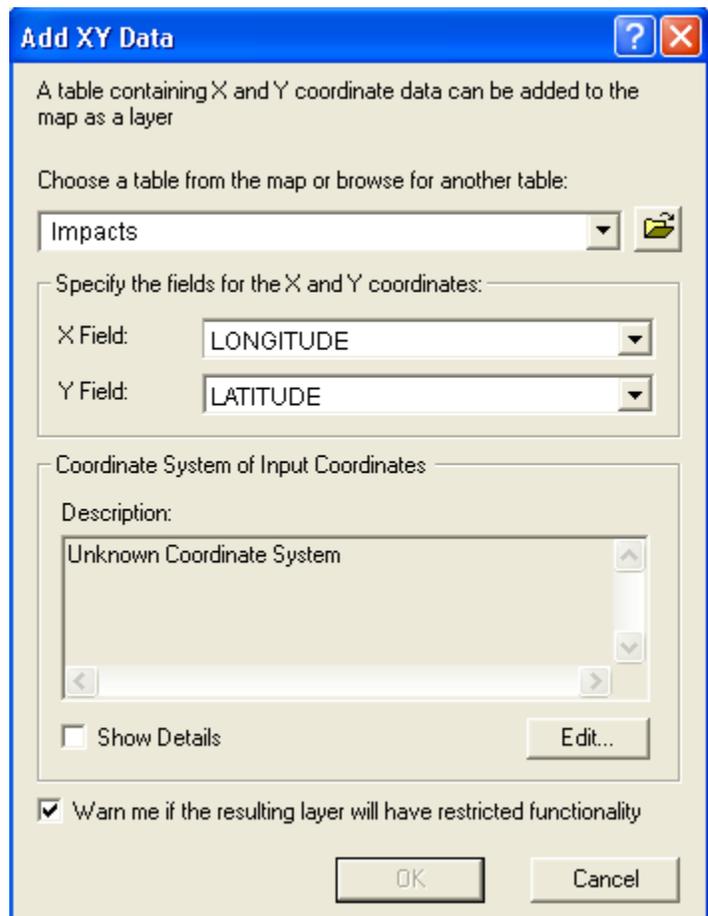
D4. Right click on the **World\_Adm** layer in the contents area and choose **Joins and Relates**. Then select **Remove Joins**. Then select **Remove All Joins**. There is now no data to map.

### Part E. Mapping Point Data

Maps are made up of one of four types of features: points, lines and polygons and raster data (images). Polygon data can depict features that have an area, such as continents, countries or states. Lines are used to depict linear features, such as faults or roads. Points can be used to depict cities, places where data was collected or other features, such as the location of volcanoes or meteorite impact sites. This section will deal with mapping point features.

E1. To add point data to a map, select the word **File** on the menu bar. A pull-down menu will appear. While holding the left mouse button down, select **Add Data**; then select **Add XY Data**. Click on the folder to connect to the Flash Drive and select the file named **Impacts.dbf**, a file showing the locations of meteorite impacts in the World. The system will automatically fill in the X and Y fields (Longitude and Latitude). Click **OK**. The locations of World meteorite impacts will now show up on the map. **Repeat this step a second time so that two sets of impact locations plotted on the map.**

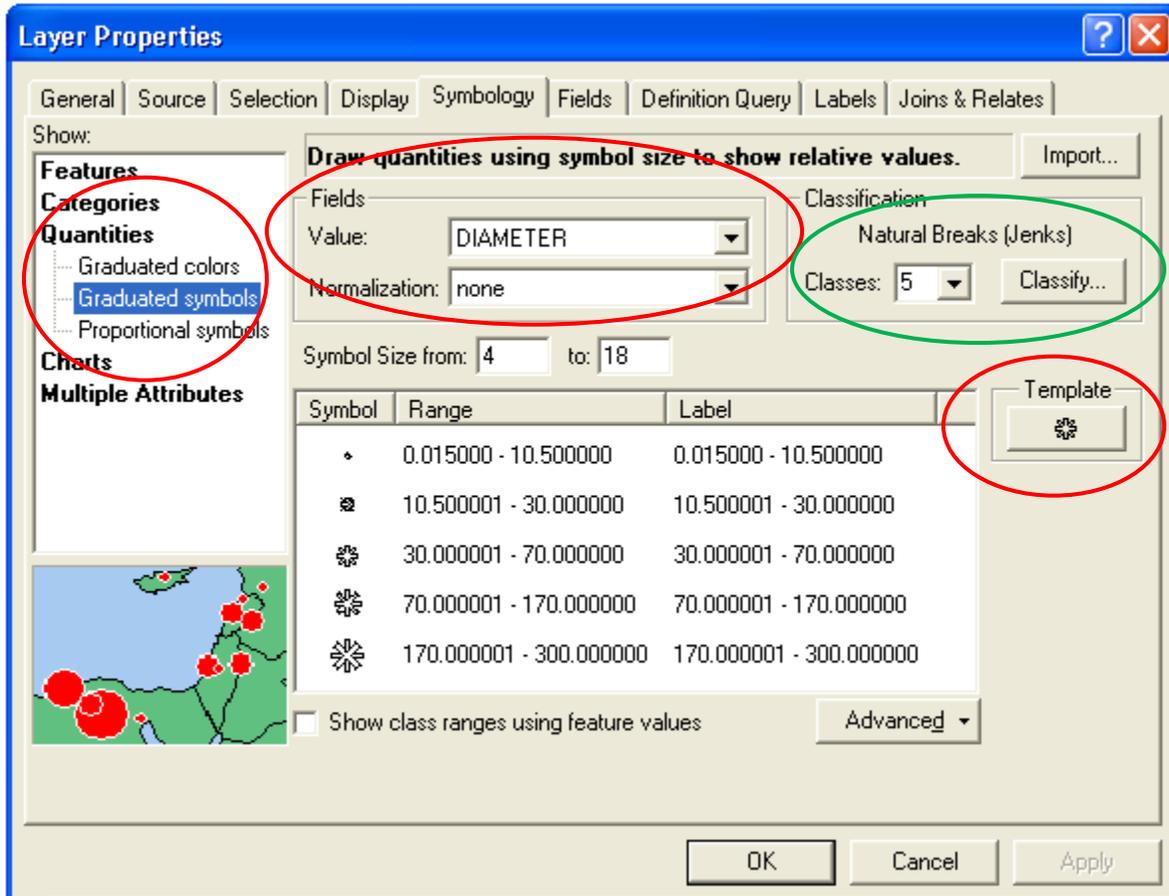
E2. Open the data table for one of the impact layers by right-clicking on the name of the data table and selecting the **Open Attribute Table** option. The data table includes information on when the meteorite impact occurred (years before present) and the diameter of the crater.



Notice that some of the latitudes and longitudes are given as negative numbers. (See the section on Entering Latitude and Longitude in a Data Table for more information.) Close the Attribute table for the **Impacts Events** data by clicking on the close file button in the upper right-hand corner of the table (the **White X**).

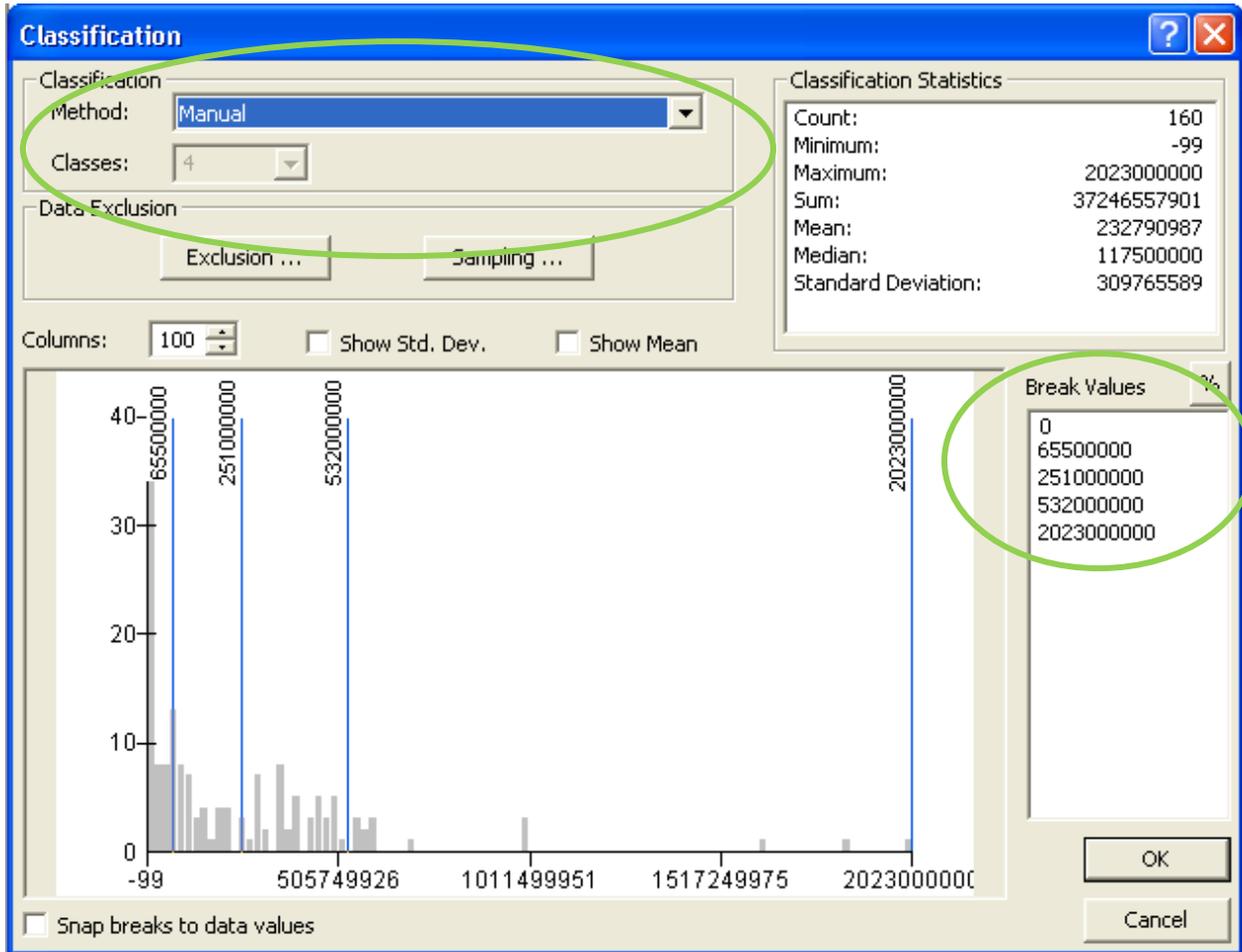
E3. To map the relative size of the craters, double click on the **lowest** of the two **Impacts Events** layers in the **Contents** area (the one that appears second in the list of data layers). If it does not already appear, click on the **Symbology** tab. The **Layer Properties** menu will appear. In the

Show area, select **Quantities** and then **Graduated Symbols**. In the **Fields** area, use the pull down next to the word **Value:** to select **Diameter**. Then click on the **Template** button to change the symbol. Use **Asterisk 3** as the symbol. Change the size of the asterisks in the boxes next to the words **Symbol Size from:** to a range from 8 to 20. Then click **OK**. The relative size of the meteorites is shown by the size of the asterisk.



E4. To map the age of the meteorite impacts, double click on the other **Impacts Events** layer in the Contents area (the one that appears first in the list of data layers). If it does not already appear, click on the **Symbology** tab. The **Layer Properties** menu will appear. In the **Show** area, select **Quantities** and then **Graduated Colors**. In the **Fields** area, use the pull down next to the word **Value:** to select **Age**. Then click on the **Classify** button (the green circle above). The **Classification** menu will appear.

E5. Choose Manual from the pull down next to the words as the **Classification Method** and change the number next to the word **Classes** to 5. Then change the first four break values to 0, and the ages associated with the beginning of the Cenozoic (65,500,000), Mesozoic (251,000,000) and the Paleozoic (532,000,000). Do not change the last value (that is the age of the oldest known impact crater). Then click **OK**. There will now be 5 age classes shown on the **Symbology** tab.



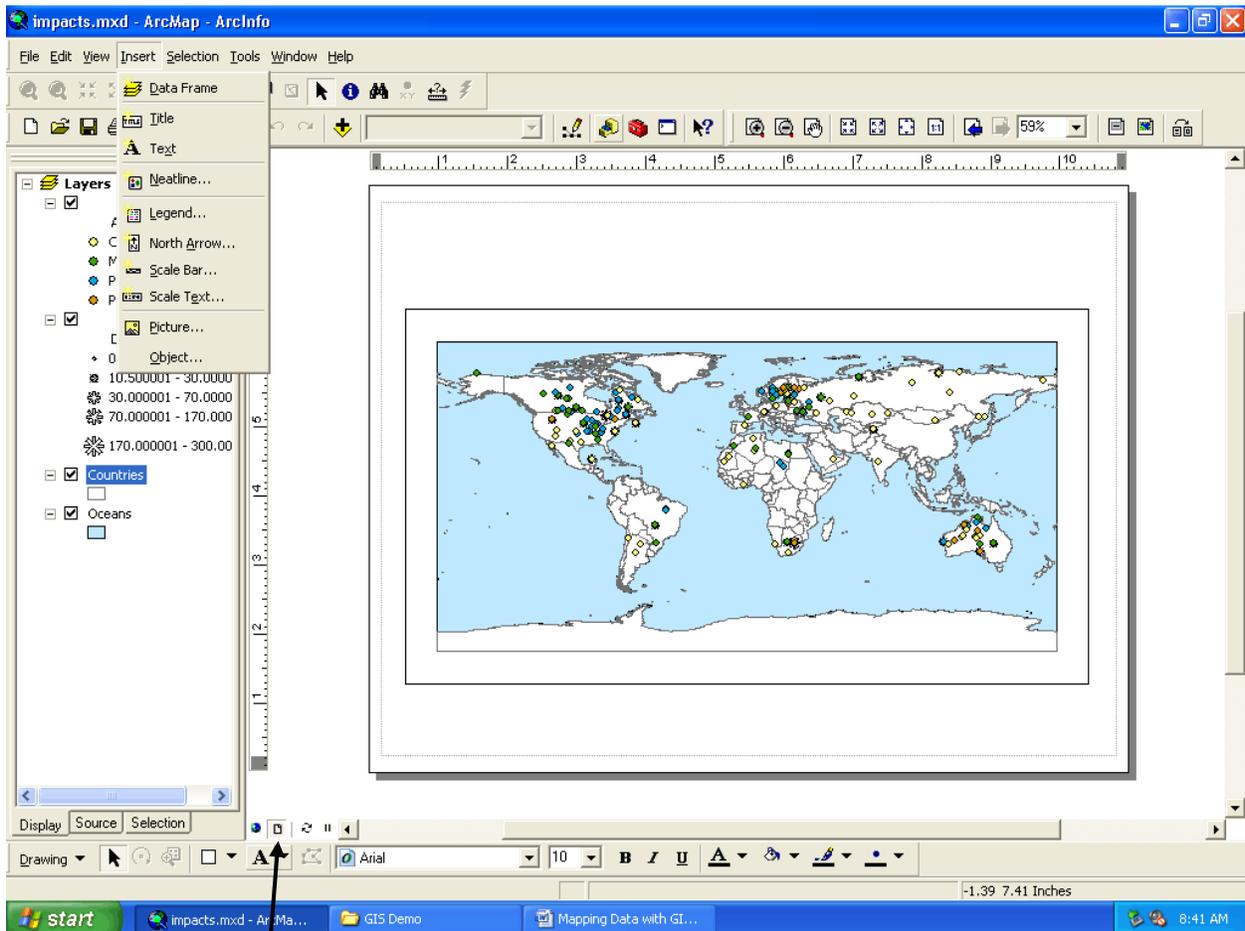
E6. On the **Symbology** tab, click on each of the numbers under the word **Label** beneath the **Color Ramp**. Change the labels to Unknown, Cenozoic, Mesozoic, Paleozoic and Proterozoic and Archean (the four major geologic eons). Then double click each of the dot symbols beneath the word **Symbol**. Change the colors to Black (Unknown), Yellow (Cenozoic), Green (Mesozoic), Blue (Paleozoic) and Orange (Proterozoic and Archean). As you change the color, also change the size of the dot to 6 (rather than 4). Then click **OK**.

## Part F. Laying out a Map

F1. Edit the names of the layers in the **Contents** area by clicking on them twice (slowly). Change the name for the **World\_Adm** to **Countries**, the name of **World\_Grid** to **Oceans**, the name of the Meteorite size layer to **Diameter (km)** and the name of the meteorite ages to **Age**.

F2. Click on the word **File** on the menu bar and select **Page and Print Setup**. In the Paper section, check to see that the paper orientation is **Landscape** rather than **Portrait**. Then click **OK**.

F3. At the bottom left corner of the **View** area, you will see two icons. One looks like a globe and the other looks like a sheet of paper with the corner folded down.  When you mouse over it the pop-up says **Layout**. Click on that icon. You will now see how the map would look like if you were going to send it to the printer. Resize the box around the map by dragging the boxes on the blue lines around the map until it is close to the edge of the map. If the map is too small, use the magnifying glass with a + sign on it from the ArcMap toolbar to increase the scale of the map. The ArcMap and Layout toolbars are shown on the next page.



Layout



F7f. The next frame in the **Legend Wizard** allows you change the spacing between elements of the legend. Just click on the word **Finish**. The legend will appear on top of the map. The legend will be active, in other words if you move the mouse over it, you will see a set of arrows indicating that you can move the legend. Click on it with the left mouse button and move it to the bottom of the map. You may have to move the other parts of the map around a little so that the legend will fit on the page. This can be done by clicking once on each component (the title, or the map itself). When they are surrounded by a box with a dashed line and squares at the corner, the item can be moved to another location.

F8. Click on the word **Insert** on the top menu bar. A pull-down menu will appear. Highlight the word **Scale Bar**. Choose the scale bar that you like. Then click on the properties button to the right of the sample scale bars. Change the number of divisions to 3 and the number of subdivisions to 2. Then change the units on the scale bar to **Kilometers** and the label position to **Below Bar**. Click **OK** twice. You may have to click on the scale bar to make it active so that you can to move it to another location outside of the map area. Move it to the lower right-hand corner of the map. If you think it is too long, use the mouse to click on the box at the right end of the scale bar and drag it to the left. This will adjust the length of the scale bar.

F9. Click on the word **Insert** on the top menu bar. A pull-down menu will appear. Highlight the word **North Arrow**. Choose the style of **North Arrow** that you want to put on the map and click **OK**. The **North Arrow** will appear, probably hidden in the middle of the map. It will be active, so that you can move it to an appropriate location. Click on it with the left mouse button and drag it to the lower right hand corner of the map (above the **Scale Bar**).

F10. The last element that you should add is some text describing who made the map and the source of the data used in the map, in other words a **Statement of Responsibility**. Click on the word **Insert** on the top menu bar. A pull-down menu will appear. Highlight the word **Text**. A text box will appear, probably in the middle of the map. You will be able to start entering text into the box, although it might be a little difficult to read what you are entering. If you hit enter, the text box will remain in the middle of the map, but it will be active so that it can be moved. Move it to the area below the map. If you quickly double click in the active text box, the text **Properties** menu will appear. Using the text **Properties** menu, you will be able to see what you are entering while keyboarding, as well as change the alignment, character spacing and font size. Enter the following information in the **Statement of Responsibility**. Be sure to hit enter after each line, otherwise your **Statement of Responsibility** will be one long line, probably wider than the map sheet.

Developed by YOUR NAME with data from  
the U.S. Geological Survey and the University  
of New Brunswick's Earth Impact Database.

Note that the **Insert** menu also allows you to add a picture, such as the logo for your library or organization. You might want to do this with your library's logo, if it has one. When you are finished, exit **ArcMap** without saving your work.

## Part G. Working with Geologic Data

G1. Start **ArcMap** by clicking on **Programs, ArcMap** and then **ArcMap**. The **ArcMap** icon looks like this: . Wait a minute or two until **ArcMap** loads. The program will ask whether you want to start using ArcMap with a new empty map, a template or an existing map. Choose a **new empty map**.

G2. Click on the **Add Data** button . The **Add Data** menu will appear. Use the **Connect to Folder** button to connect to  the Flash Drive drive. Open the **GIS Data** folder.

Add the data named **Faults, Glacial, USGeology** and **States**. Look in the Contents area. The data should appear in the following order from top to bottom: **Glacial, States, Faults, and USGeology**. If it is not in that order, use the mouse to click on the data layer with the left mouse button. While holding the left mouse button down, drag the layer to the correct place in the contents. Repeat these steps until the data is in the correct order. (you may have to click on the list order buttons under the words **Table of Contents**).

G3. Click in the check box next to the **States** layer to turn it off. You will notice that the Geology layer is made up of a lot of different areas. Turn the **States** layer back on by clicking in the check box again. The **States** layer covers the geologic features. Double click on the **States** layer. The **Layer Properties** menu will appear. Click on the **Symbology** tab. This tab allows you to change the appearance of a feature on a map. Click on the button in the **Symbol** box. The **Symbol Selector** menu will appear. You will see a lot of different symbol options on the left side of the **Symbol Selector**. Choose **Hollow** with the mouse and change the **Outline Width** (under the preview area) to **1** by clicking on the up arrow once. Click **OK** twice. You will see that the States are no longer filled in with a solid color.

G4. Double click on the **Glacial** layer, which is a line showing the maximum extent of the last glacial advance. The **Layer Properties** menu will appear. Click on the **Symbology** tab. Click on the **Symbol** button. Change the line feature to a **4:4** dashed line (it is a little more than  $\frac{3}{4}$  of the way down in the symbol selector). Set the color to black and the line width to **2**. Then click **OK** twice. The line showing the maximum glacial advance on the map is now a dark dashed line. Repeat these steps with the **Faults** layer. Make them a solid black line with a width of **1.5** (you will have to enter the width by hand). Click **OK** twice.

G5. In this part of the exercise, the **USGeology** data will be coded based on the age of the rocks. Double click on the **USGeology** layer. The **Layer Properties** menu will appear. Choose **Categories** and **Unique Values**. Set the **Value Field** to **Age**. Click on the **Add All Values** button and click **OK**. You will see that the rocks of each age are shown in a different color. Because the colors are based on geologic ages, they should be shown from oldest to youngest according to their age. They should appear in the following order:

- Quaternary
- Neogene
- Paleogene
- Tertiary
- Cretaceous and Tertiary
- Cretaceous
- Mesozoic
- Mesozoic, Lower
- Paleozoic and Mesozoic
- Paleozoic
- Paleozoic, Upper
- Paleozoic, Middle
- Paleozoic, Lower
- Proterozoic and Paleozoic
- Proterozoic
- Proterozoic, Late
- Proterozoic, Middle
- Proterozoic, Early
- Archean
- Water
- Unknown

To rearrange the order of the ages in the **Contents**, double click on the **USGeology** layer again. The **Layer Properties** menu will appear. Click in the check box next to the words **All Other Values** to turn the check mark off. Then click on the top layer beneath the word **Heading** (the word Archean). You will notice that the arrow buttons to the right of the symbol area becomes active. Click on the down arrow button until it is just above the word **Unknown**. Then highlight the word **Unknown** and move it to the bottom of the list. Repeat this process until all of the ages are in the correct order. Then click **OK**. You will notice that the rock ages now appear in the correct order in the map area.

G6. In this section, the colors for the rock ages will be set to show the color for that time period. Geologic maps use color schemes based on standards related to the geologic time scale. Two different schemes are used. One was developed by the Commission for the Geologic Map of the

World (CGMW) and the other was developed by the USGS. Colors shown on USGS geologic maps are based on standards that were developed in the late 1800s. USGS colors are used for large-scale and regional geologic maps of the United States. For international maps or small-scale maps (for instance, 1:5 million) of the United States or North America international colors are used.

Double click on the **USGeology** layer in the contents area. Then double click on each of the 21 layers in the list of rock ages. Click on the **Fill Color** button. When you move the cursor over a color in the color picker, you will see that a color name appears. Set the colors so that they are similar to the colors shown on the USGS geologic time scale at:

<http://pubs.usgs.gov/fs/2007/3015/>. Suggested colors are as follows:

Age	Color
Quaternary	Solar Yellow
Neogene	Sahara Sand
Paleogene	Mango
Tertiary	Electron Gold
Cretaceous and Tertiary	Olevenite Green
Cretaceous	Leaf Green
Mesozoic	Fir Green
Mesozoic, Lower	Malachite Green
Paleozoic and Mesozoic	Jadeite
Paleozoic	Moorea Blue
Paleozoic, Upper	Big Sky Blue
Paleozoic, Middle	Medium Lilac
Paleozoic, Lower	Peony Pink
Proterozoic and Paleozoic	Medium Coral
Proterozoic	Rose Dust
Proterozoic, Late	Nubuck Tan
Proterozoic, Middle	Tecate Dust
Proterozoic, Early	Leather Brown
Archean	Gray 20%
Water	Lapis Lazuli
Unknown	White

As you change the color for each layer, click **OK** once. When you have finished changing the last color, click **OK** twice. The colors in the map will now reflect the rock age.

G7. Use the zoom in button on the toolbar (it looks like a magnifying glass with a plus sign in the middle) to zoom in on your state. Use the identify button to click on one or more rock units in your state. A table will appear showing details about that rock unit.

G8. Add labels to your map by double clicking on the **USGeology** layer in the contents area. Click on the Labels tab. Use the pull-down next to the words **Label Field** to set the label to **MAPUNIT\_SY**. Click **OK**. Then right click on the **USGeology** layer and select **Label Features**. You will see that a small label appears on each rock unit shown on the map.

## Mapping Other Data

The Flash Drive includes other data, including:

- **States** – Boundaries for U.S. States
- **States48** – Boundaries for the 48 contiguous U.S. States
- **Coal.dbf** – Coal Use, Production and Coal Mines for U.S. States
- **Volcano.dbf** – Locations of World Volcanoes and when they last erupted
- **Cities.shp** – Locations of World cities with data on their population and type.

Using what you have learned in the previous exercise you can map

- Coal production or use or the number of mines in the United States
- Locations of Volcanoes and when they last erupted

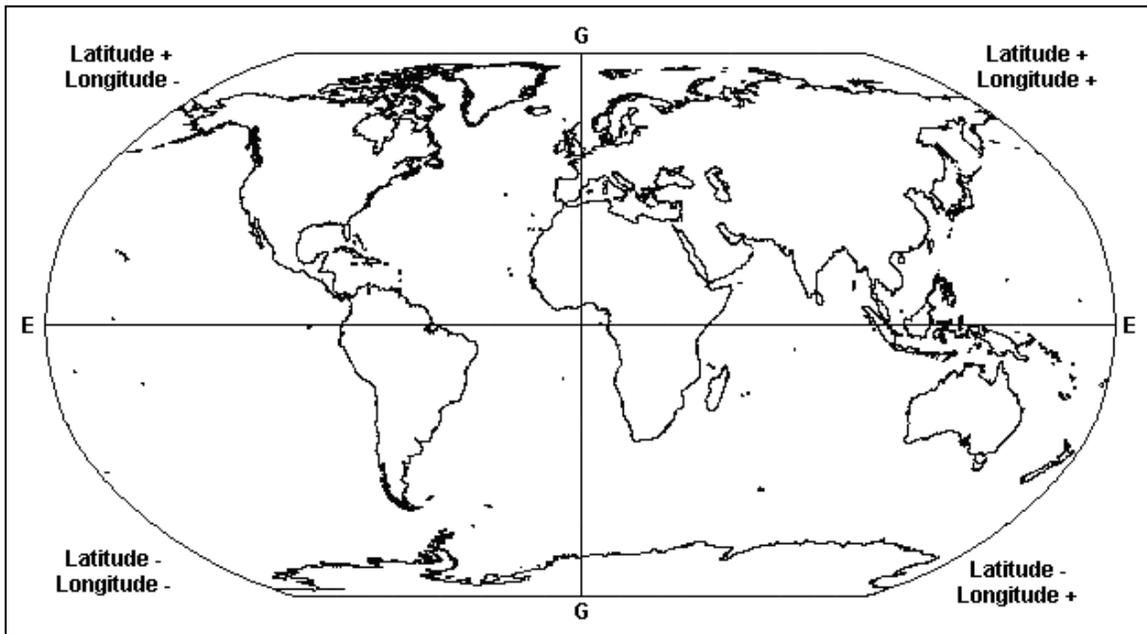
### Developing a GIS Data Table

1. Find a source of data that you wish to map, for example the data on World Gold Mine Production by Country in the Gold section of part I of *Minerals Yearbook*. Copy the data from the PDF document into a word processing document. Delete any footnote symbols (r, e, 3, etc.) in the word processing document. Then replace the spaces with Tabs. Before proceeding further, go back and replace the tabs in country names (e.g. Burkina Faso) with spaces. Then copy the text from the word processing document into a spreadsheet program (like Excel).
2. Make sure that each row and column in the spreadsheet contains data. Fill in any spaces that have no data (those that have two dashes) with a number; the number that you use should be one that does not appear in the data set (such as -99). When the data is mapped, this number will indicate that there is no data for that country and year.
3. Find a list of Country FIPS Codes (there is one in Appendix D of the *CIA World Factbook*). Copy and paste the list into a spreadsheet; delete every column except the FIPS code. Fill in the entire spreadsheet with 0 (the number zero). Copy the gold production data for each country onto the end of the file with the country FIPS codes. Be sure to add each column heading to the top of the spreadsheet. Your data table will have the following headings: Country, FIPS, 2001, 2002, 2003, 2004, and 2005.
4. Save the data file that you made as a .csv file. To convert it into a .dbf file you will have to add the .csv file to ArcMap (using the add data button) and then export the file as a .dbf file. ArcMap 9.2 can also use Excel spreadsheets, but the column headings did not translate on the file that I used. (It is also not compatible with Office 2007 files).

**Why use a table with FIPS Codes?** The data table that you create will be joined to a set of geographic data. Because you cannot be certain whether the country names will be in the same format (for example that the word Saint could be spelled out or abbreviated; Myanmar could be called Burma), it is easier to use a computer code, such as the FIPS (Federal Information Processing Standards) code, to join the data in a table to the geographic data.

## Entering Latitude and Longitude in a Data Table

Latitude is measured north & south of the Equator, while Longitude is measured east and west of the Prime Meridian at Greenwich, England. To make it easier for the software to read latitude and longitude, they are entered as positive and negative numbers instead of letter-number combinations for north, south, east and west. Latitudes are positive north of the Equator and negative south of the Equator. Longitudes are positive east of the Greenwich Meridian and negative west of the Greenwich Meridian. (See illustration below).



Numbers for latitude and longitude should be entered in decimal degrees instead of degrees, minutes & seconds.