

Introduction to GIS – A Journey Through Gale Crater

In this lab you will be learning how to use ArcMap, one of the most common commercial software packages for GIS (Geographic Information System). Throughout this lab you will be learning a bit more about GIS software, but we'll also be using this software to plan a rover mission on Mars.

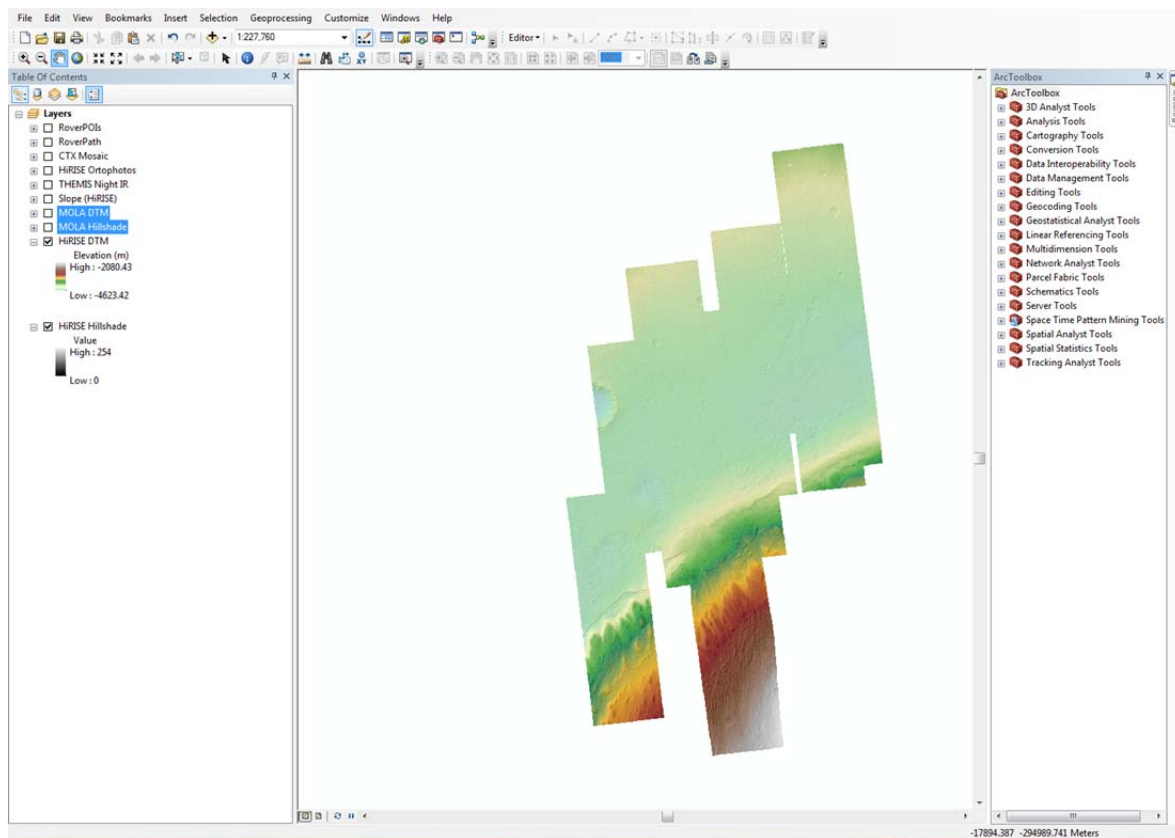
INSTRUCTIONS:

A) Opening and using ArcMap Documents:

TASK: To open ArcMap, click on the 'Start' menu and navigate to 'ArcGIS' and then 'ArcMap'. For this lab, we've already created an ArcMap project for you to use, so once ArcMap is open, either use the window that may appear at startup or navigate with 'File' > 'Open' to the location of the ArcMap project as indicated by your instructor. This project file will be called 'Gale' and will have an icon that looks like a magnifying glass on a globe.

This 'mxd' file is a map document. It is important to realize that a map document saves the locations and display properties of data used in a map project, and does NOT save the actual data. For example, if you wanted to send someone your map file, you would need to send them this 'mxd' file AND all of the data files that are used in the map file.

Once the project file is done loading, you should see something like this:



The ArcMap window is divided into four main areas: (1) just like with many programs, along the top are icons for frequently used tools; (2) on the left is the 'Table of Contents' which is a list of all the data currently loaded into the ArcMap project; (3) on the right are additional menus that allow you to access more advanced tools and navigate to different data; and finally (4) the center of the display is where loaded data is displayed.

TAKS: Before we do anything else, we want to save a new version of this map project with a new name. Go to 'File' > 'Save As' and save the map project where your instructor has indicated with your initials, e.g. 'Gale_AMF'.

B) Interacting With the Table of Contents:

ArcMap allows you to view and interact with multiple different datasets at once and you can use the Table of Contents window to control which datasets are displayed, the order in which they are displayed, and how they are displayed.

If you look at the table of contents, you will see lists of names of datasets like 'CTX Mosaic' and 'HiRISE DTM' and next to each name there is a check box and a little plus or minus. The check box controls whether that dataset is displayed in the data window (it is checked) or not (it is not checked) and the plus or minus controls how much detail you see about the display properties of that dataset.

When you opened the project, only 'HiRISE DTM' and 'HiRISE Hillshade' are visible because these are the only two datasets which have been checked.

Question 1) Click the checkbox to turn on the 'MOLA Hillshade' layer. What happened to the display (i.e. what dataset do you see in the display)? When you're done with the question, turn off 'MOLA Hillshade'

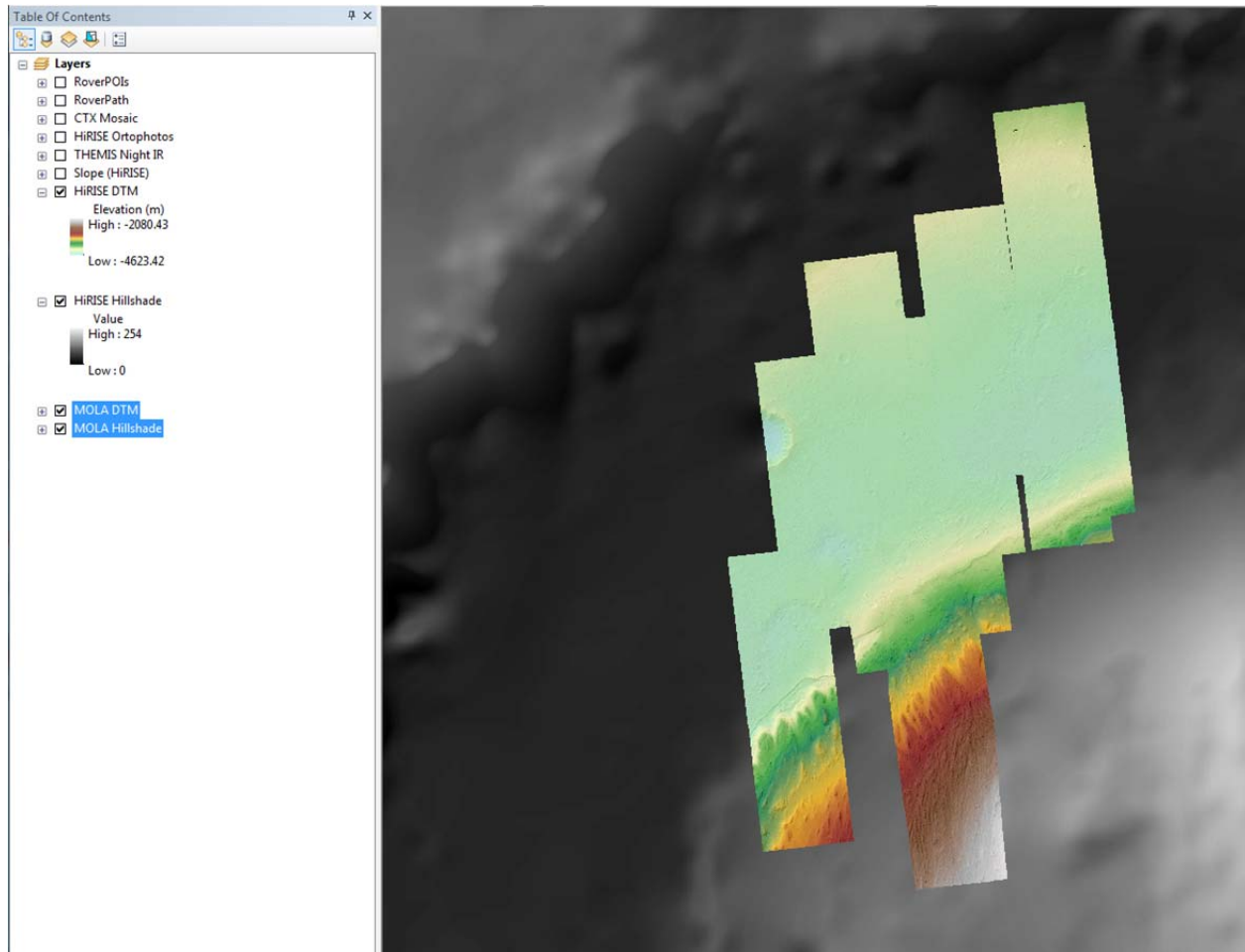
As you can see from when you turned on the 'MOLA Hillshade' layer, the order of items in the Table of Contents controls the order that data is displayed. Layers listed higher in the Table of Contents will be drawn after (on top of) layers listed lower in the Table of Contents. You can change the order anytime you want by left-clicking and holding on the name of the layer and then dragging it to the position you want.

TASK: Go ahead and click and drag both the **MOLA DTM** and **MOLA Hillshade** layers below the **HiRISE DTM** and **HiRISE Hillshade** and then save your map project (you can save by just clicking the disk icon in the toolbar). Both the **MOLA DTM** and **HiRISE DTM** have been set to be transparent (you'll learn how to control this shortly) so you can see the Hillshade beneath the DTMs.

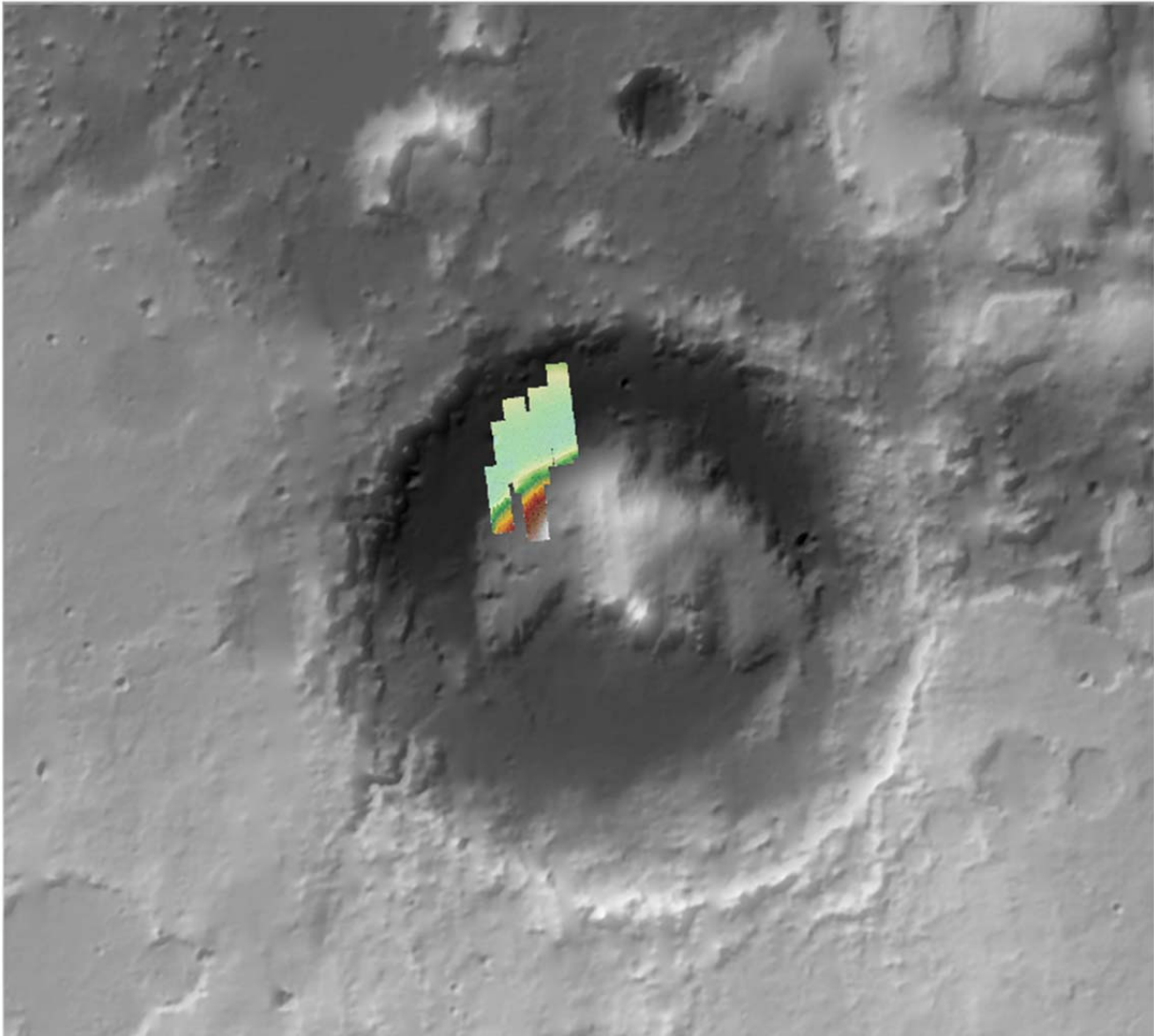
C) Rasters and Changing Their Display Properties

Depending on the type of data, within ArcMap you have a lot of different options for how that data is displayed.

TASK: To start, make sure that **HiRISE DTM**, **HiRISE Hillshade**, **MOLA DTM**, and **MOLA Hillshade** are all turned on and that the MOLA datasets are below the HiRISE datasets, so your display and table of contents should look like this:



It looks like the two MOLA datasets are a lot larger than the HiRISE dataset, so let's zoom out to see the context. Look on the tool bar for the magnifying glass with the + or – signs, these will allow you to zoom in or out. Alternatively, you can right click on either **MOLA DTM** or **MOLA Hillshade** and select 'Zoom To Layer' and it will automatically zoom out so you can see the full extent of these two MOLA datasets, and you'll see a view like this:

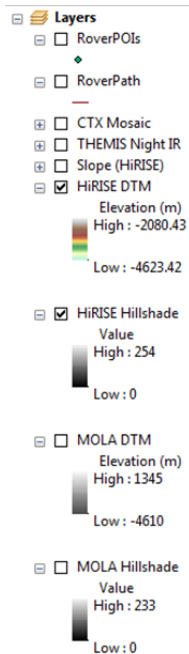


It should be clear now that we are looking at a crater, specifically Gale Crater on Mars. The four layers we have displayed are actually just two different kinds of data. The 'DTM' layers, or Digital Terrain Models, are grids of x,y, and z values which record the elevation of an area. The 'Hillshade' layers were created from the DTMs using ArcMap, where the elevations are made into a three dimensional surface and then 'illuminated' to produce bright areas (parts of the topography facing the light source) and dark areas (areas in shadow or facing away from the light source), just like if the sun was low on the horizon and lighting up the topography. Hillshades are useful to help you see the topography. To illustrate this, turn off the two DTM layers and see the difference.

In this case, the two groups of DTMs and Hillshades come from two different satellite instruments orbiting Mars. MOLA (Mars Orbiter Laser Altimeter) is an elevation dataset that covers the entire planet of Mars but is low resolution (you can only see large scale features). HiRISE (High Resolution Image Science Experiment) records images and elevation at much finer scale (you can see very detailed features) but this data only exists for a small portion of Mars.

All four of these layers are what we call ‘rasters’, which are similar to any image. Just like an image from a camera, each raster is made up of individual pixels, and each pixel has a location (x and y coordinate) and a series of values. Some rasters, like color photographs, can be complicated and have multiple values at a single pixel. Color photos usually have values that correspond to the amount of red, green, and blue that whatever is displaying that photo (e.g. your phone) use to display the correct color. In the case of the rasters here, they have a single value at each pixel, which means something different depending on the raster.

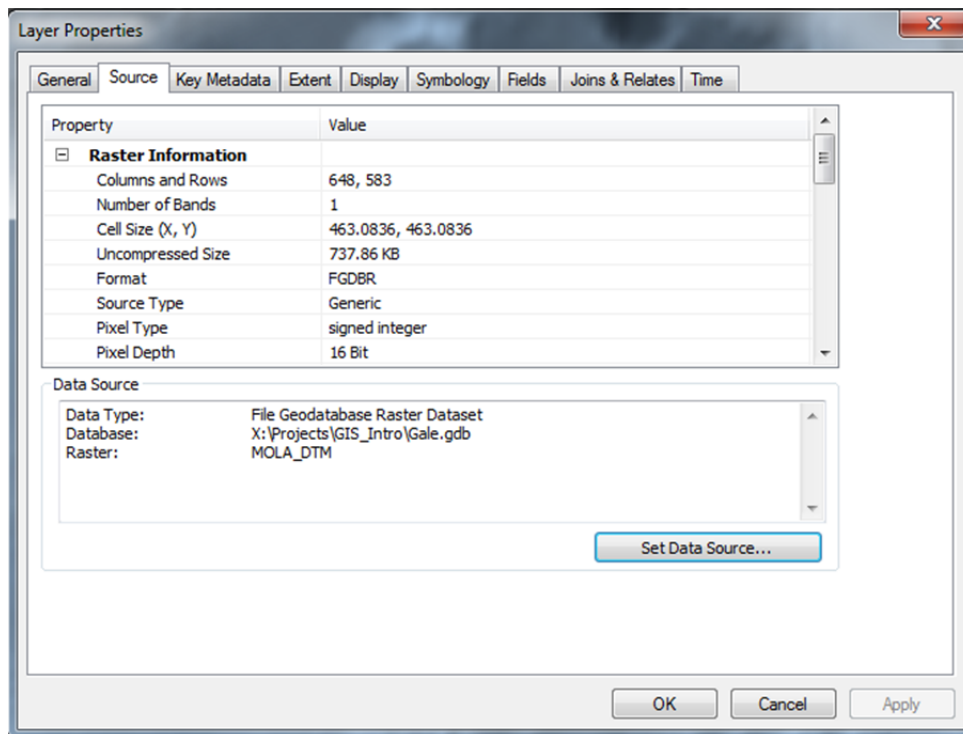
TASK: To look at these values, let’s expand the details of our four layers of interest in the Table of Contents by clicking the + signs to make them – signs. Your Table of Contents should now look like this:



For the ‘Hillshade’ rasters, these values are exactly like with a normal image, but the single value is for grayscale, so each pixel is a value between 0 and 255 with 0 being black and 255 being white. For the digital terrain models, the values are elevation in meters. The color that we see displayed for these two DTM layers come from doing a ‘stretch’, or assigning a color ramp to the values stored in the raster, and we can modify this stretch anytime we want for any layer we want.

What we now want to do is to make the stretch of the MOLA and HiRISE DTMs the same so our view looks like a more consistent dataset. To do this, we need to change the display properties of the layers.

TASK: Right click on the **MOLA DTM** and select ‘Properties...’ from the menu and you will see a window like this:



This Layer Properties window allows us to change many aspects of how this layer is displayed, but also query information about the layer itself.

TASK: Click on the 'Source' tab along the top to see basic information about the layer like what kind of data it is, the file size, where the file is saved, geographic location of the data in the file, etc. One useful property is the 'Cell Size (X, Y)', which is the size of a single pixel in real world units. In the case of the datasets here, this value is in meters.

Question 2) Use the Layer Properties dialogue to determine what the Cell Size is for both the **MOLA DTM** and **HiRISE DTM** layers. How many pixels of HiRISE data would fit into a single MOLA pixel?

TASK: Return to the Layer Properties window for the **MOLA DTM** layer and click on the 'Symbology' tab. From this menu, you can change how the data is displayed. Make sure 'Stretched' is selected in the list at the top left of the dialog box. There are many different types of stretches, the default is usually 'Standard Deviations'. You can move the dialog box so that you can see some of the data and experiment with different stretches. After you've selected one, click 'Apply' and the display will update so you can see the difference. Above the type of Stretch is the 'Color Ramp'. From this drop down you can select different color ramps to apply to the data and you can try out different ones in the same way with the 'Apply' button. You can pick any color ramp you like, but make sure the stretch is set 'Minimum-Maximum'. This is often the most useful stretch because this is a 'linear stretch', meaning that the color scale and the data range directly correlate. With the 'Minimum-Maximum' stretch, you can click on the 'Edit High/Low Values' checkbox and change the values between which the stretch occurs. For the **MOLA DTM** layer, change the minimum and maximum values to -4500 and 1200,

respectively. When you've picked a color ramp, set the stretch to 'Minimum-Maximum', and change the min and max values, click 'OK'.

TASK: Now, open the Layer Properties window for the **HiRISE DTM** layer and click on the 'Symbology' tab. We could fiddle with the stretch and the minimum and maximum values to try to get the stretch to be exactly the same as the **MOLA DTM** layer, but instead we can click on the folder symbol at the top right of the dialog window to load the display properties of another layer. This will bring up a drop down menu to Import Symbology from a specified layer, use it to find the **MOLA DTM** layer and select it and then press OK and the press OK again back on the main dialogue window.

TASK: The MOLA and HiRISE DTMs should now be the same color, but it would be nice if the MOLA and HiRISE data were a little easier to tell apart when zoomed out. Go back to the Layer Properties for the **MOLA DTM** and click on the 'Display' tab. You'll see a number of options you can change, but find the 'Transparency' property. We've made both the HiRISE and MOLA DTMs partially transparent so we can see the hillshades through them, but let's go ahead and make the **MOLA DTM** 80% transparent. Depending on the color ramp you chose, your display should now look like this:



Now, let's take a look at the other rasters we have available: **Slope (HiRISE)**, **THEMIS Night IR**, and **CTX Mosaic**. The **Slope (HiRISE)** raster is also derived from the **HiRISE DTM** layer, but it shows the slope angle of the topography, measured in degrees. The **THEMIS Night IR** raster is from the THEMIS (Thermal Emission Imaging System designed here at ASU) instrument and is an infrared image taken at night. The amount of infrared radiation emitted by an object tells us generally how hot that object is and looking at infrared radiation at night tells us how much heat an area has retained from the day. Generally, areas with high Night IR are areas with high 'thermal inertia', or materials that are slow to heat up or cool down like solid rock, whereas areas with low Night IR have low thermal inertia, or are materials that heat up and cool down very quickly, like loose sand. The **CTX Mosaic** raster is essentially a grayscale satellite image.

TASK: Do not change the stretch on the **CTX Mosaic** raster, but go ahead and experiment with changing the stretch and color ramps on the **Slope (HiRISE)** and **THEMIS Night IR** rasters.

D) Vector Data and Their Display Properties

The other main type of data you can visualize and manipulate in ArcMap is vector data, either in the form of points, lines, or polygons. Within Arc, these data are referred to as 'Shape Files' or 'Features'. Just like with raster data, there a range of display options and operations you can perform on vector data. There are two vector data layers loaded into the Gale project, **RoverPOIs** (which stands for Rover Points of Interest) and **RoverPath**, only **RoverPOIs** has data in it, you'll be adding data to **RoverPath** in a little while.

TASK: To start, turn on the **RoverPOIs** layer and then use the right click menu to zoom into this layer. You should see a series of points on the high resolution DTM like this (NOTE that you will see more points in your version of **RoverPOIs** though):

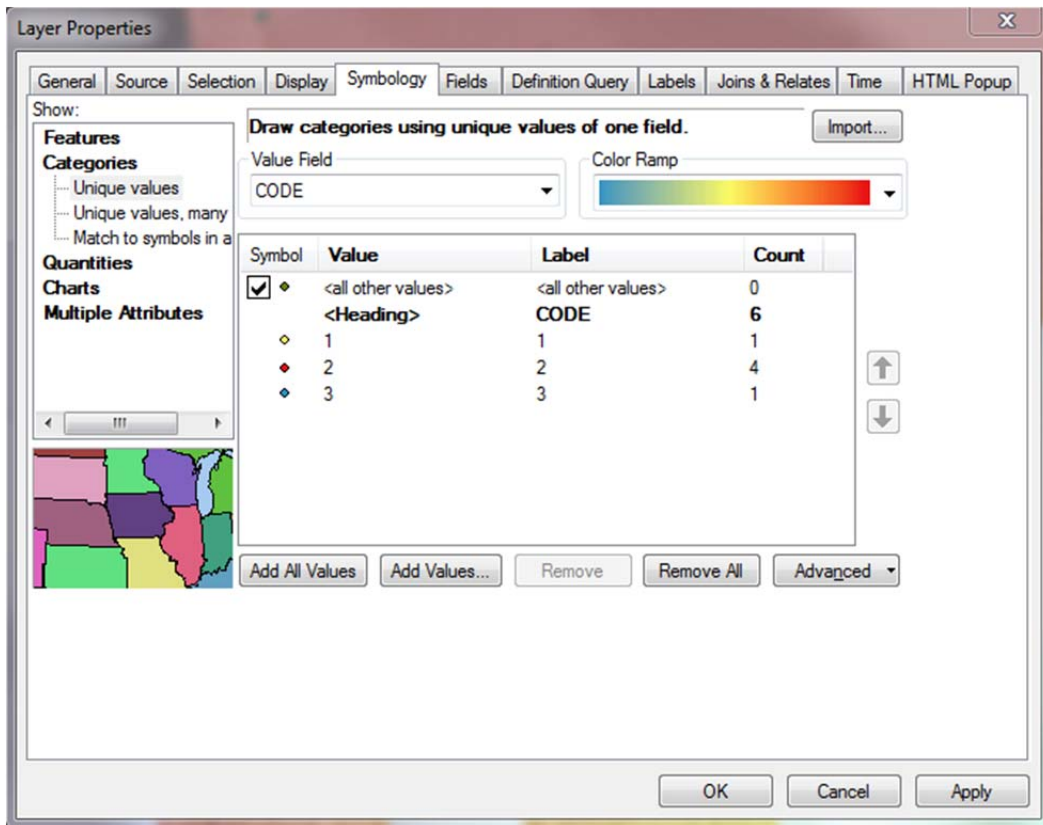


Vector data can have lots of information associated with each object in a particular dataset, and this information is stored in a table called an 'Attribute Table'. Each column of an Attribute Table is called a 'Field' and can contain numbers or text. You can view the Attribute Table of a layer from the right click menu.

Question 3) Open the attribute table for **RoverPOIs**. How many fields does this feature have and what are the names of those fields?

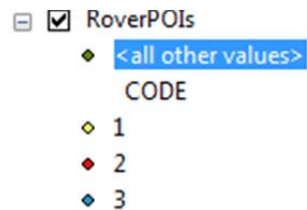
The values in fields can be used to change the display properties of individual shapes within a layer. In the case of the **RoverPOIs**, this feature is storing points of interest for a Mars rover. The description for the point of interest is stored in the 'LABEL' field and they are broken up into three categories with the 'CODE' field.

TASK: Right click on the **RoverPOIs** and select 'Properties...' and then the 'Symbology' tab. In the left hand menu, select 'Categories' and then 'Unique Values'. In the drop down menu under 'Value Field', make sure that the 'CODE' field is selected, and at the bottom of the dialog box, click the button labeled 'Add All Values'. At this point, the dialog box should look something like this:



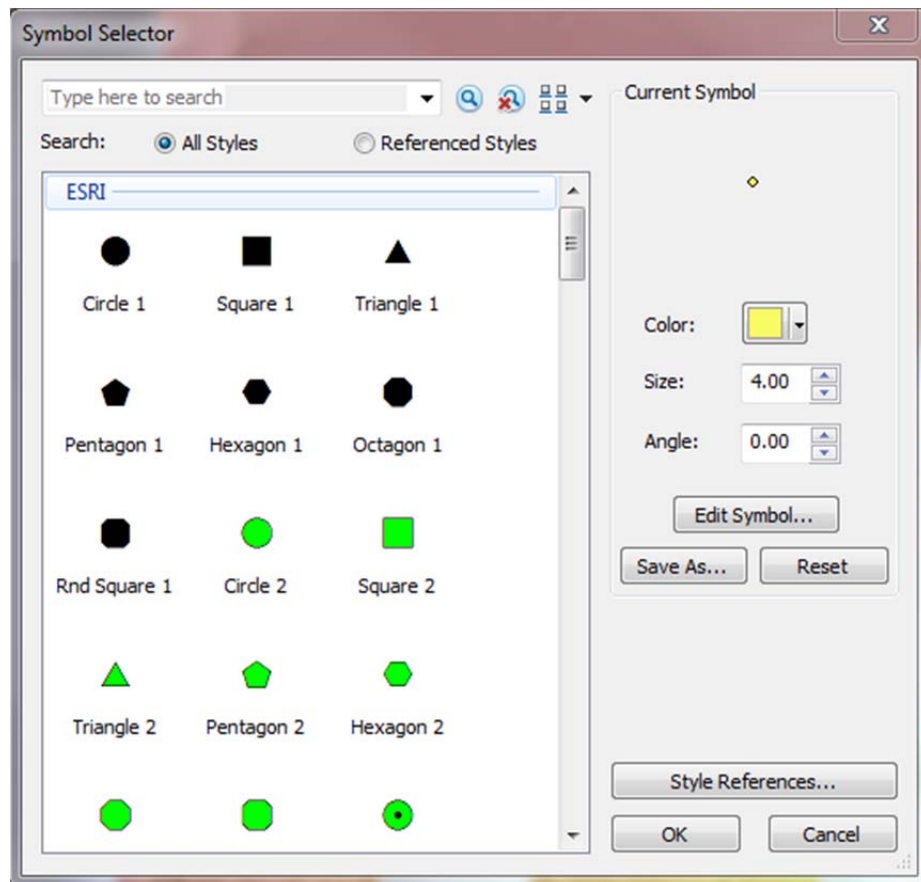
This has used the values stored in the 'CODE' field to set up different symbols for the three different values in this field. Compare this with what happens if you set the Value Field to 'LABEL' and click 'Add All Values' again. Before you close the Layer Properties, make sure to reselect 'CODE' under Value Field and click 'Add All Values' again. Once you have done that, click 'OK'.

When you return to the data view, you should see that the points now have three different colors and the entry for the **RoverPOIs** in the Table of Contents should look like this:

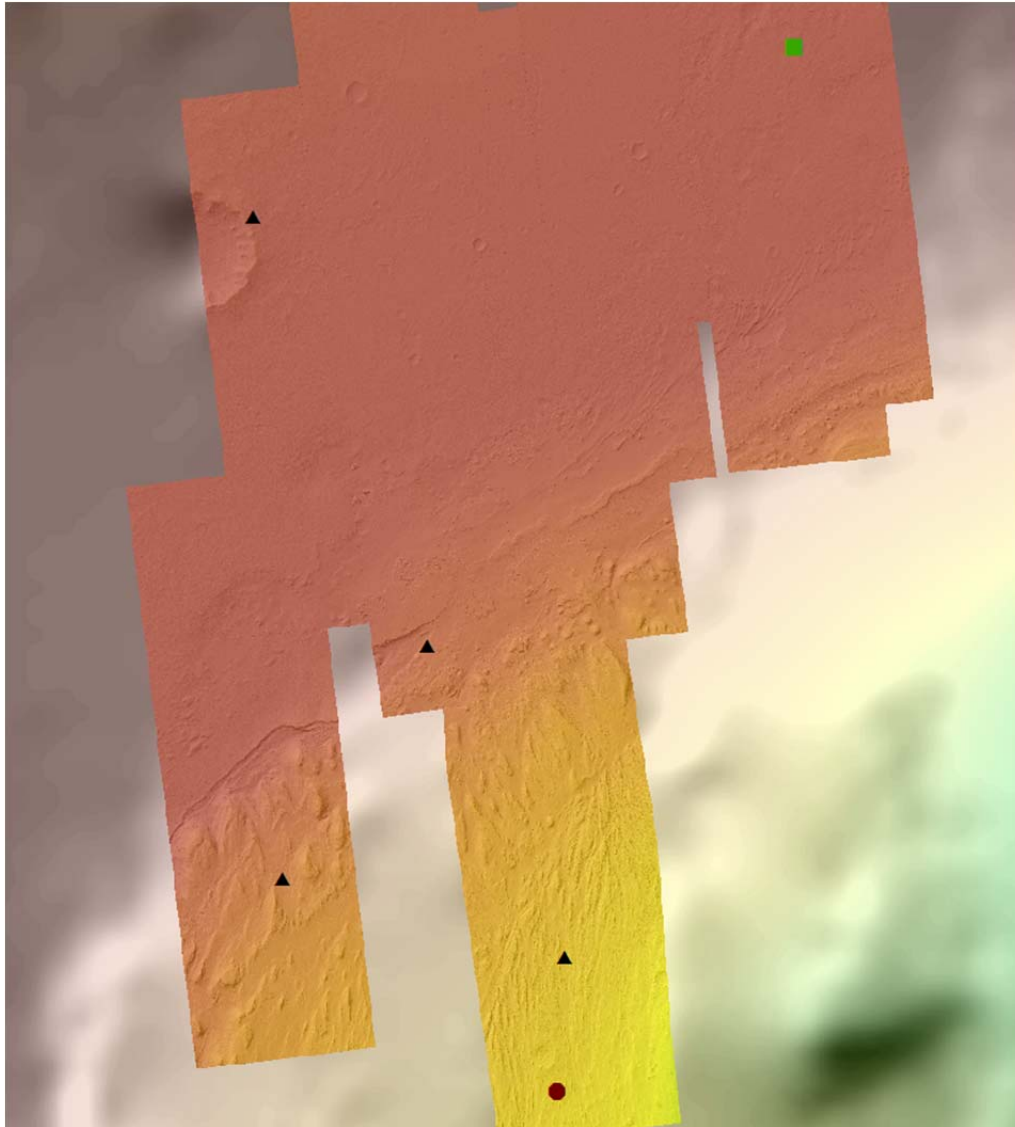


The different colors help to differentiate these, but you can make them more distinctive by changing their size and shape as well. You could do this in the Layer Properties dialog, but you can also do this directly from the table of contents.

TASK: First, open the attribute table for **RoverPOIs** so that you can refer to it if it's not already open. Now, left click on the symbol next to the '1' in the Table of Contents, this should bring up a dialog that looks like this:

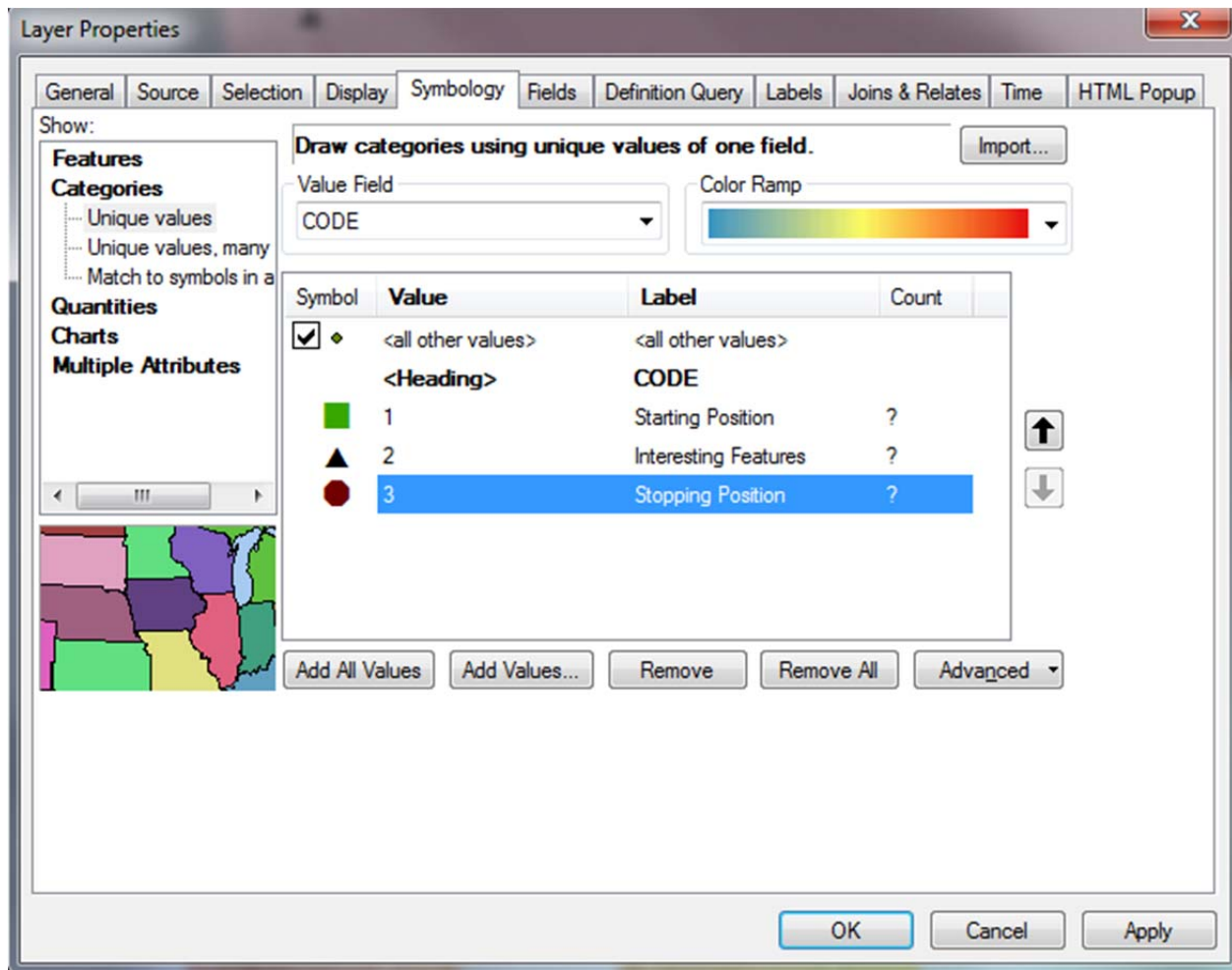


TASK: From this dialog you can change the properties of this one symbol. If you look at the LABEL field in the Attribute Table, you'll see that the description for CODE 1 is 'Landing Spot', so this will be the starting path for our Mars rover, so let's make the symbol for this a green square (doesn't matter which exact square or which shade of green). Also, change the size of the symbol to 15 and click 'OK' when you're satisfied with the changes. We want to do the same thing for the other two codes, change the CODE 2 symbol (which are stops along the path of our rover) to black triangles and the CODE 3 symbol (ending point for our rover) to a red octagon. When you're done, your map should look something like this:



Now, because you've looked at the attribute table, you know what the three codes mean, but it would be nice if the Table of Contents was a little clearer. Thankfully, we can change how the values of the codes are displayed in the Table of Contents.

TASK: Open the 'Layer Properties' for **RoverPOIs** and under 'Symbology', highlight the numbers in the 'Label' column and change CODE 1 to 'Starting Position', CODE 2 to 'Interesting Features', and CODE 3 to 'Stopping Position'. The Layer Properties dialog should look like this:



Once that's done, click 'OK'.

E) Editing Vector Data – Plotting the Rovers Path

There is an additional vector data layer in your project called **RoverPath**. If you expand it in the Table of Contents, you'll see that it is a line, but if you turn its visibility on you won't see anything appear in the data view, that's because it's empty! (You can confirm this by opening the Attribute Table for this layer and seeing that there are no entries) You are going to make a series of lines in this layer that will outline the path of a rover mission on Mars. We'll get to how to do this in a moment, but first there are a couple of rules for where the rover needs to go and where it also can and cannot go:

Rules for Rover Travel:

- 1) The path of the rover needs to start at the 'Starting Position' and end at the 'Stopping Position'.

- 2) NASA has identified various points of geologic interest along the way, these are marked as 'Interesting Features'.
- 3) Visiting a point of geologic interest adds 1 day to the travel time (the rover will spend time at that point of interest taking measurements).
- 4) The rover cannot travel over topography with a slope greater than 50 degrees.
- 5) The rover engineers are worried about damage to the wheels, so the rover needs to minimize its time driving over bedrock.
- 6) The maximum speed for the rover is 0.1 kilometers/hour.
- 7) NASA can only guarantee that the rover will run for 45 days, so the rover must reach the 'Stopping Position' within 45 days of landing.

DISCUSSION BREAK

Once you've reached this point let your instructor know. Either individually with your instructor or as a class you will want to discuss the best strategy for plotting the rover's course. Below are some tips, but you'll want to consider how you can use the data you have to try to follow the rules and get the most science done that you can in the 45 day life of the rover!

Tips for Plotting the Rovers Path:

- 1) You will not be able to visit all of the points of interest, but you want to try to maximize the number that you do visit (remember to account for the 1 day it takes to analyze whatever the rover finds!).
- 2) You will need to switch between different datasets as you plot the course for the rover.
- 3) Recall that high values in a night time infrared image indicate bedrock.
- 4) There is limited coverage for the **HiRISE DTM** and slope map made from it, but sometimes the most direct path between areas of interest may be across gaps in the data. You can use an image (like the **CTX Mosaic**) or other datasets to get an idea of the type of terrain the rover would have to drive across.
- 5) It may be helpful to change the stretch or transparency of some of the layers so you can see the hillshades or multiple layers at once (e.g. changing the stretch on the **Slope (HiRISE)** layer so that any angle greater than 50 degrees can be seen clearly will help you avoid areas with slopes greater than 50).

Use the attribute table to see what each point of interest is and start deciding which you want to try to visit with the rover (you will probably have to change your plans as you go if your path takes too long for the rover to traverse).

To plot the course of the rover, you will need to edit the **RoverPath** layer. The first step is making sure that the correct tools are available. In the toolbar along the top of the ArcMap window, there should be a set of tools that looks like this:



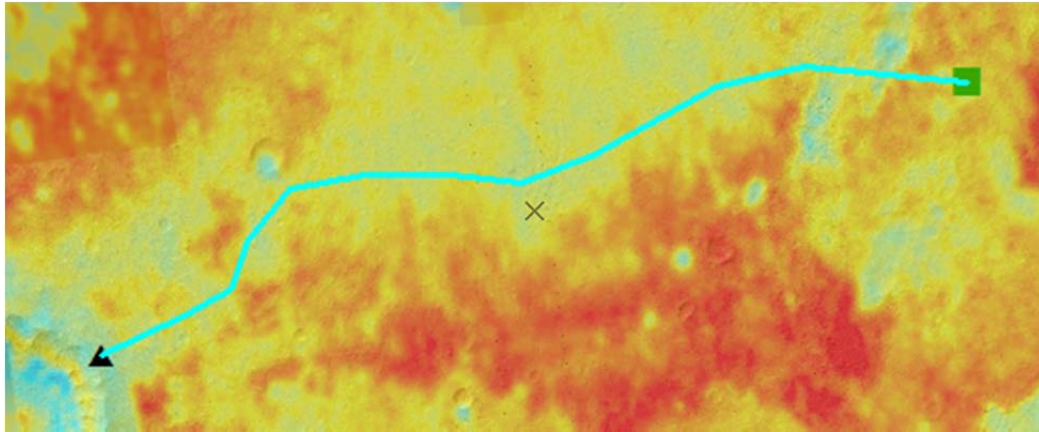
If you don't see a set of tools like this, go to 'Customize' > 'Toolbars' and from the long list of toolbars, make sure that there is a check mark next to 'Editor'. Checking this will make the Editor toolbar appear and you can drag it to a convenient place. Toolbars in Arc can either be free floating or 'docked' to one of the sides of the map window. If you drag the Editor toolbar up to the top of the window it will 'dock' to the other toolbars that are already open.

TASK: Once you have the 'Editor' toolbar turned on, click on 'Editor' and from the dropdown menu, select 'Start Editing'. A dialog window will show up listing the features that you can edit within this project, make sure that **RoverPath** is highlighted and then click 'OK'. If you look back at the Editor toolbar, several buttons that were grayed out should now be clickable, the far right button in the Editor toolbar looks like a list of check boxes and if you hover the mouse over it, it will tell you that this is the 'Create Features' option, click it. This will open a new panel on the far right side of the program window, that will look something like this:

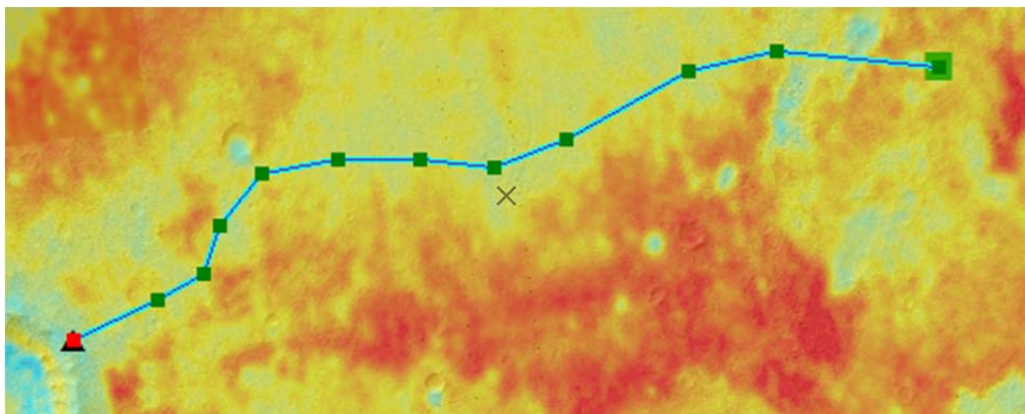


Make sure that **RoverPath** appears in the list of features to be created and then highlight it. Once you do, the previously empty 'Construction Tools' part of the window will be populated with a series of options. The default will be 'Line', which is what you want.

TASK: If you move your cursor back to the map, you'll notice it is now a cross hair which means you are ready to start drawing a line. Left clicking will place a node. Place the first node on the 'Starting Position' that you marked with a green square. Once you've placed the node and move your cursor, you'll see that the program shows you the line it will draw, go ahead and place another node by left clicking. Keep placing nodes to draw a course between the 'Starting Position' and the first 'Interesting Feature', just east of the large prominent crater. As you're placing nodes, if you want to delete nodes you can use Ctrl-Z to undo the placement of nodes. When you want to finish a line segment, double click. Your rover path now should look something like this:



In the above image, the color is the **THEMIS Night IR** and the path has been drawn to avoid the high values (red) as these might be bedrock. If you need to change the path of your rover you can edit the line by first clicking on the button that looks like an arrow head right next to the word 'Editor' in the editor menu and then double clicking on the line. Once you do this, the nodes will be displayed:



If you need to change any of the locations of nodes, just left-click and drag the node to where you want it to be placed. You can also right click on a node and select 'Delete Vertex' from the pop up menu if you wish to remove a particular node. Once you're happy with the edits you've made, just click somewhere off the line to deselect it.

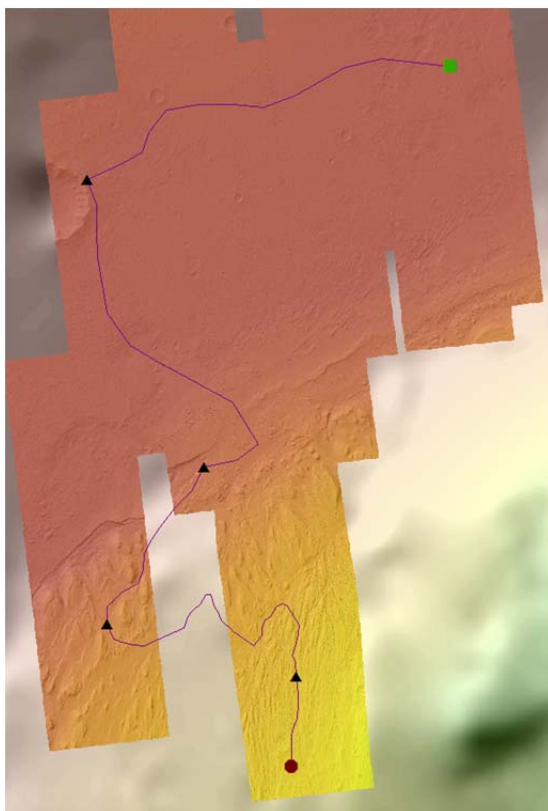
TASK: While editing features, anything you do is temporary until you save the edits so it's a good idea to periodically save what you've done. To do this, go back to the 'Editor' drop down menu and select 'Save

Edits'. **NOTE:** This is different than saving the map project with 'File'>'Save', saving the map project will NOT save edits you've made to vector features.

Once you have features like lines, points or polygons, you can use ArcMap to calculate various properties associated with those features. For the **RoverPath**, this dataset was setup to automatically calculate the length of individual line segments, which we can view by opening the 'Attribute Table' and looking at the 'SHAPE_Length' field. In this case, the units are in meters. You should be keeping track of the length of the rover's path is as you go to make sure the rover can reach its destination before the end of the 45 day operating period!

TASK: To make the next line, click back on **RoverPath** in the 'Create Features' panel on the right side of the window and continue drawing the rover's path. Make each segment between the different points of interest a separate line (i.e. finish the line by double clicking when you reach the next 'Interesting Feature'). Save your edits along the way and remember to follow the 'Rules for Rover Travel' listed above. When you're done with the path for your rover, make sure you've saved the edits and then from the 'Editor' menu, select 'Stop Editing'.

Make sure to calculate the total time for the rover (including time to analyze points of interest!) and make sure that the path can be driven in 45 days. When you're done, you're path might look something like this (remember you have more points than are shown here so your path and display will be different!):

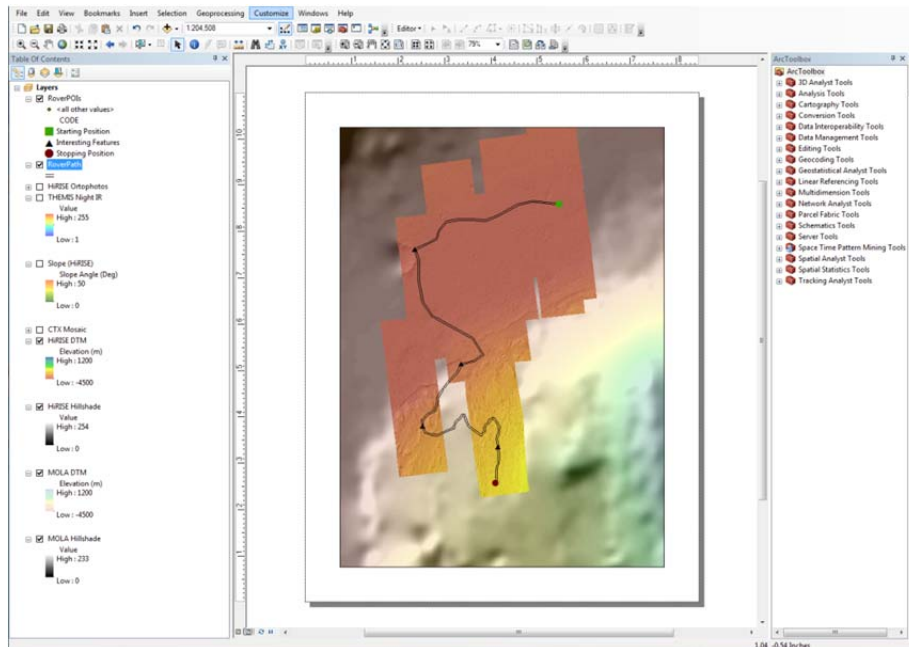


TASK: The default line can be hard to see, so just like with the point data, you can change how your rover path is displayed. You can use the 'Layer Properties' dialog of just click on the line in the 'Table of Contents'. Scroll down the list of possible lines until you find 'Double, Plain' and select it.

F) Exporting a Map

ArcMap is useful for visualizing and analyzing data, but it can also be used to produce maps and figures. In the last section, you will use ArcMap to produce a map of the rover path you've created. To do this, we need to switch the 'View'. Until now, you have been working entirely in 'Data View', but now we want to switch to 'Layout View' to see how our map would look printed out.

TASK: To switch to 'Layout View', go to 'View' > 'Layout View'. Alternatively, you can switch between 'Data View' and 'Layout View' with two very small buttons at the bottom left hand corner of the map display (hover over them with the cursor to see which is which). Once you've switched to 'Layout View', your display should look something like this:



While in Layout View, you can still change how and which data is displayed, but you will only see data within the 'Data Frame'.

TASK: Go to 'File' > 'Page and Print Setup'. This menu allows you to control the size and orientation of the paper on which your map will be displayed. Make sure the Paper Size is set to 'Letter' and the Orientation is set to 'Portrait'. Then click 'OK'.

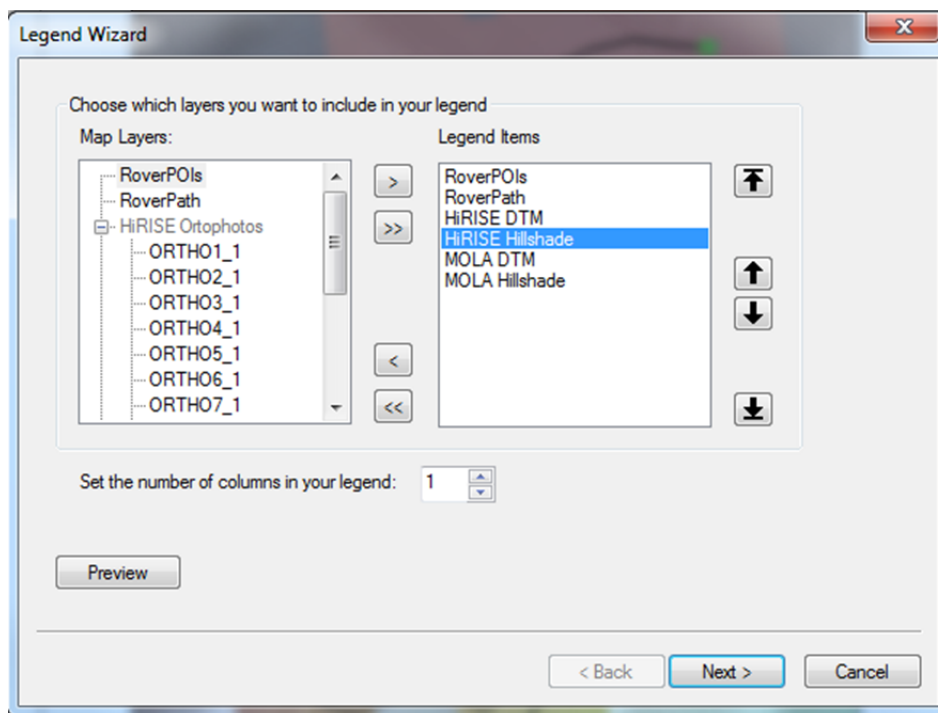
TASK: Next, go to 'View' > 'Data Frame Properties'. There are lots of options for changing or querying various aspect of the data frame, but for now navigate to the 'Size and Position' tab. This controls the size of the window displaying data on the page. Make sure that the 'Anchor Point' is in the bottom left corner and change the Y Position to '1.5 in', leave the X Position as '0.75 in'. Next change the width to '5

in' and the height to '8 in' and then click 'Apply'. You will see that the size and position of the data changed. Click 'OK'.

TASK: You can change which part of the data is displayed in the Data Frame by using the zoom (magnifying glass with + or -) and pan (hand) buttons. Use both of these to center your rover path and zoom in so most of the frame is taken up with the rover path. Finally, make sure all of the data you want to include on the map is visible. Your final map should include the **RoverPOIs**, **RoverPath**, **HiRISE DTM**, **HiRISE Hillshade**, **MOLA DTM**, and **MOLA Hillshade**.

While the bulk of a map is the data displayed on it, there are other pieces of information that you always need to understand a map, including a legend explaining what data is displayed, a scale bar so that you can measure distances, a title so you know what kind of map you have, and something indicating an orientation for the data (e.g. a north arrow). Over the next couple of steps, you'll add all of these to your map.

TASK: To add an explanation, go to 'Insert' > 'Legend'. A dialog called 'Legend Wizard' will appear that will walk you through creating a legend. This wizard will automatically add any visible layer to the column of 'Legend Items'. Some of these we want to display, but some we don't need, specifically we don't need either of the hillshade datasets. To remove an item from the legend, highlight it and click the single arrow pointing to the left between the 'Map Layers' and 'Legend Items':



Click 'Next>' at the bottom. The next screen allows you to change the name of the Legend, leave that all the same and click 'Next>' again. The following menu controls borders, select a '1.0 point' line from the 'Border' dropdown menu and then click 'Next>'. The following menu controls details of how some of the legend items are displayed, don't change anything and click 'Next>'. The final menu controls spacing

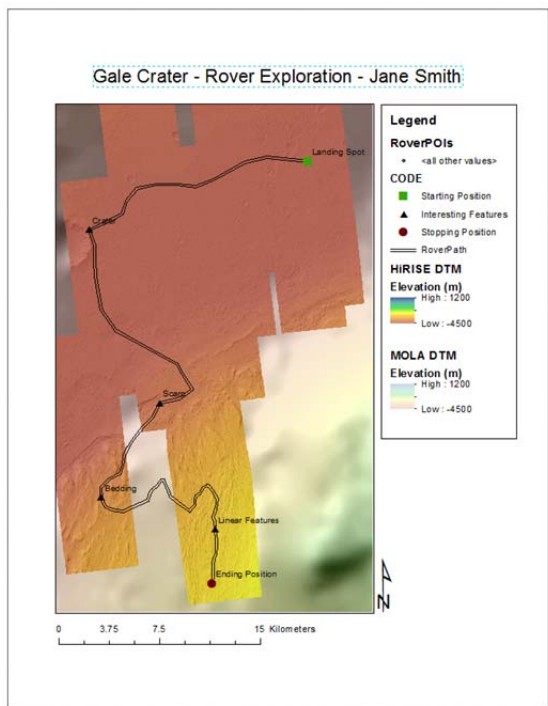
between menu items, for now, don't change anything and click 'Finish'. ArcMap will generate a legend, but it will probably put it in a silly place (like right in the middle of the page). Move the legend to the right side of the map in the white space. If the legend doesn't fit entirely on the page, you can grab one of the corners of the legend (while it is selected) and scale it so that it fits.

TASK: To add a scale bar, go to 'Insert' > 'Scale Bar'. Scroll down on the menu that pops up until you find the metric scale bars. Pick any metric scale bar and then click 'OK'. Move the scale bar to the bottom left of the map in the white space. If you stretch the scale bar horizontally, it will increase the distance covered by the scale bar, if you stretch it vertically, it will change the size of the font. Adjust the scale bar until it reaches 15 kilometers and the text is readable.

TASK: To add a north arrow, go to 'Insert' > 'North Arrow'. Choose a north arrow and then click 'OK'. Move the north arrow into the white space at the bottom right and scale it as you want.

TASK: To add labels to the **Rover POIs**, open the Layer Properties for the layer and go to the 'Labels' tab. Make sure to click the checkbox at the top left that says 'Label features in this layer'. Use the drop down menu to select LABEL as the 'Label Field' and then click 'OK'. You may need to adjust the size of the text in this menu or the position of the map with the pan tool to make sure that labels are fully visible.

TASK: Finally, to add a title, go to 'Insert' > 'Title'. Name your map what you would like, but make sure to include your name. If you need to change the text of your title after you have inserted it, go to 'File' > 'Map Document Properties' and edit the title text. Your map should look something like this by this point:



TASK: The last step is to save the map in a format people without ArcMap can view. To do this, go to 'File' > 'Export Map'. Navigate to where ever you'd like to save the map, give it a file name that makes sense for you, and set the type to 'PDF' and then click 'Save'.

FINAL WRITE UP:

Congratulations! You've now planned a rover mission on Mars and created a map of your exploits! Now you need to prepare a report documenting why you chose the points of interest and rover path that you did. This write up should be less than half a page, but it must include the total distance the rover will travel, the number of points of interest the rover will visit, and your estimation of how long this journey will take.