Lab 8 – Landscapes of Mars

ASTR 1010

Name: _____

Overview

In this activity you will use elevation maps and images of the surface of Mars to compare its geography to Earth. As part of this process you will also explore evidence to support the claim that Mars had flowing water in the past. Finally, you will learn about the Tharsis Bulge on Mars and discuss the history of volcanic activity on Mars.

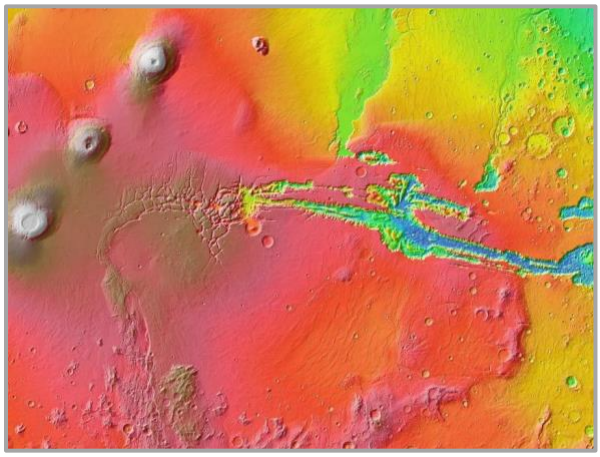
Objectives

After completing this activity students will be able to:

- Interpret elevation maps of Earth and Mars
- Use elevation maps to determine the direction of water flows on Earth and Mars
- Discuss two geographic examples of evidence for past water flows on Mars
- Describe what the Tharsis Bulge region is on Mars
- Explain how surface smoothness and cratering relate to past volcanic activity on Mars

Definitions

Here are some terms that we will be using today in lab:



- **Elevation Maps** – Geographic maps that have been color coded so that different colors indicate different vertical elevations. White, red, and orange colors typically indicate high elevation areas such as mountains or plateaus. Black, blue, and green colors typically indicate low elevation areas such as valleys or craters.
- **Kasei Valles & Eberswalde Crater Delta** – Two different geographic regions on the surface of Mars that show indications of past water flow.
- **Tharsis Bulge** – A region of high elevation on the surface of Mars that hosts volcanos, canyons, smooth terrain, and few craters.

Part 1. Elevation Maps of Earth and Mars

To understand elevation maps, you will start by looking at the familiar geography of Georgia and the surrounding southeast region. Open the Elevation Map of Georgia. Notice the color bar to the right of the map. Higher elevations are shown in white, red, and orange. These are the Appalachian Mountains. Lower elevations are shown in green and blue. This is the coastal plain. The lowest elevation is 0 feet at sea level.

Clicking anywhere on the elevation map will tell you the elevation at that point, measured in feet (ft). Use this to answer the following questions.

1. Click on several spots in the region of mountains in north Georgia to get a sense of their elevation. What is the typical elevation of the mountains, in units of feet? You do not have to be exact; an estimate will do.

2. Do the same around Atlanta. What is the typical elevation of Atlanta?

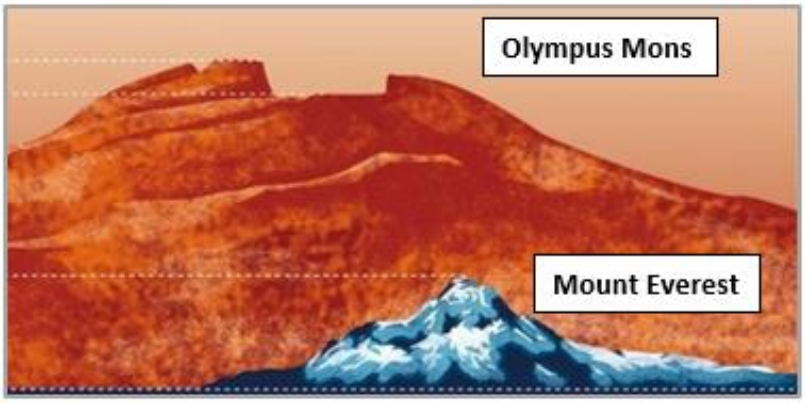
3. What is the typical elevation around Savannah, GA?

You will now explore an elevation map of Mars. Open the Elevation Map of Mars. Zoom out slightly so that you can see all of Mars within the map. North is at the top and south is at the bottom. The equator of Mars runs left and right through the middle of the map. East is on the right and west is on the left. As you move east or west, the map simply repeats itself over and over. The color scheme is the same as the Earth map, with higher elevations shown in white, red, and orange, while lower elevations are shown in green and blue. The numbers next to the color bar in the lower left corner now indicate the elevation in kilometers (km).

Mars does not have liquid water on its surface, so there is no sea level to provide a zero point for elevation like there is on Earth. Instead, scientists choose a particular elevation as the zero point and measure relative to that. This causes some locations to have negative elevations, such as large impact basins. **You can search for the specific named locations referred to in the following questions using the search bar above the map.**

4. The highest elevation on Mars is the peak of Olympus Mons, an enormous volcano near the center of the map. Based on the colormap and color bar, what is the highest elevation at the peak of Olympus Mons, in units of kilometers? You do not have to be exact, simply provide an estimate.

5. Mount Everest on Earth has an elevation of 8.85 kilometers, making it smaller than Olympus Mons! How much taller is Olympus Mons compared to Mount Everest, in units of kilometers?



6. The lowest elevation on Mars is within Hellas Planitia, a large impact crater in the southern hemisphere. Based on the colormap and color bar, what is the lowest elevation in Hellas Planitia, in units of kilometers? You do not have to be exact, just provide an estimate. This could be a negative number.

7. Based on the height of Mount Everest provided in Question 5 and your answer to Question 6, would Mount Everest be able to stand upright inside of Hellas Planitia without poking over the top of the crater?

Part 2. Water on Earth and Mars

You are now ready to study how water has shaped the geography of Earth and Mars. Start by going to the Elevation Map of Vinings, Georgia and the surrounding area. The Chattahoochee River flows from north to south, as indicated by the lower elevation blue areas. Rain that falls in higher elevation areas such as Smyrna and Sandy Springs flows downhill into the Chattahoochee River. Over time, this flow of water from high elevations to low elevations has eroded the surface, creating channels along the river.

Return to the Elevation Map of Mars and search for "Kasei Valles." This will put two pins down in a region north of the equator. Zoom in to study this area more closely. Kasei Valles is a canyon system thought to have been created by a catastrophic flood in the distant past. Use this view of Kasei Valles, combined with what you just learned above about how water flows on Earth, to answer the following questions.

1. Did the Kasei Valles floodwaters flow from west to east (left to right) or east to west (right to left)? Explain your reasoning using the elevation map.

Now zoom out to the full Mars elevation map and consider the general elevation differences between the northern and southern halves of Mars.

2. If Mars ever had an ocean, would it more likely be located in the northern or the southern hemisphere of Mars? Explain your reasoning using the elevation map.

After it passes through Atlanta, the Chattahoochee River continues to flow south until it reaches the border of Florida, where it joins other water sources and becomes the Apalachicola River. It then flows into the Gulf of Mexico, creating a delta. In a delta, a single large river fans out into many smaller streams. Images of the Apalachicola River Delta can be seen in Figure 1 on the next page.

Now search for "Holden Crater" on the Mars map. This is a relatively small area so you will have to zoom in to see it. Very nearby immediately north of Holden Crater is a smaller crater named Eberswalde Crater, which hosts the Eberswalde Crater Delta. These craters can be seen labeled relative to each other in Figure 2 on the next page.

3. Is the elevation inside these craters higher of lower than the terrain to the west?

4. Based on this, would water flow into the craters, or out of the craters?

5. Compare the Apalachicola River Delta shown in Figure 1 to the Eberswalde Crater Delta shown in Figure 2 on the next page. What sort of similarities do you see?

Multiple interpretations are possible, so just describe what you see in as much detail as you can.

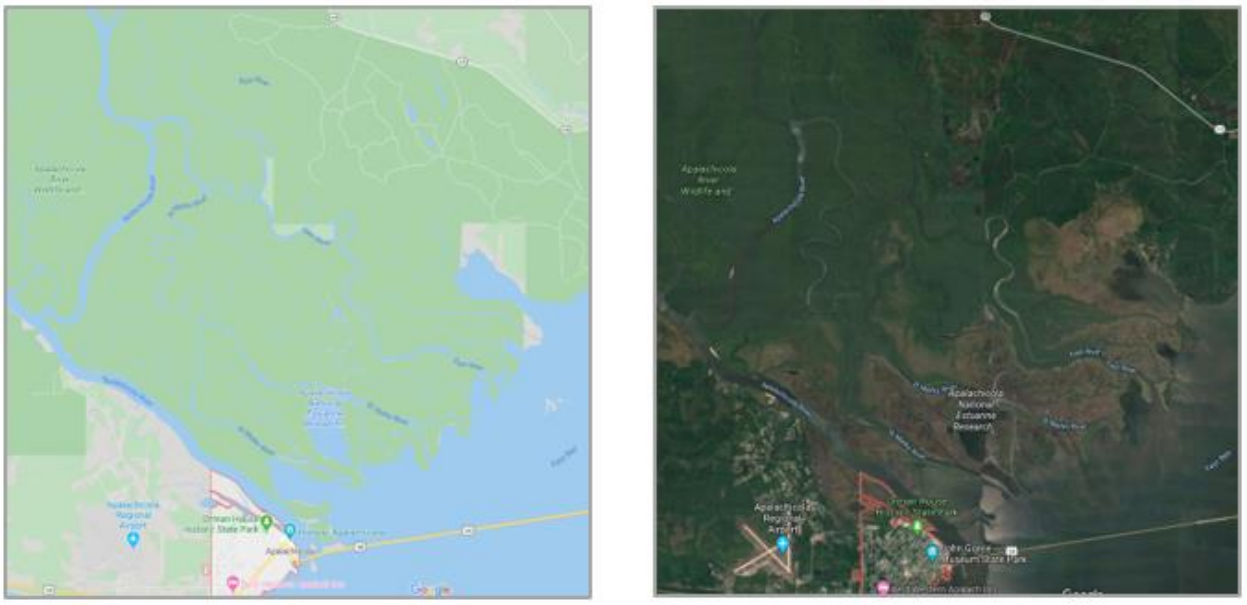


Figure 1: The Apalachicola River Delta in Florida, USA, Earth. These two images show the same view, one in a maps schematic form (left) and the other showing a true satellite image of the delta (right). These images demonstrate how deltas appear with many tendril-like branching rivers spreading out and pouring into a large body of water.

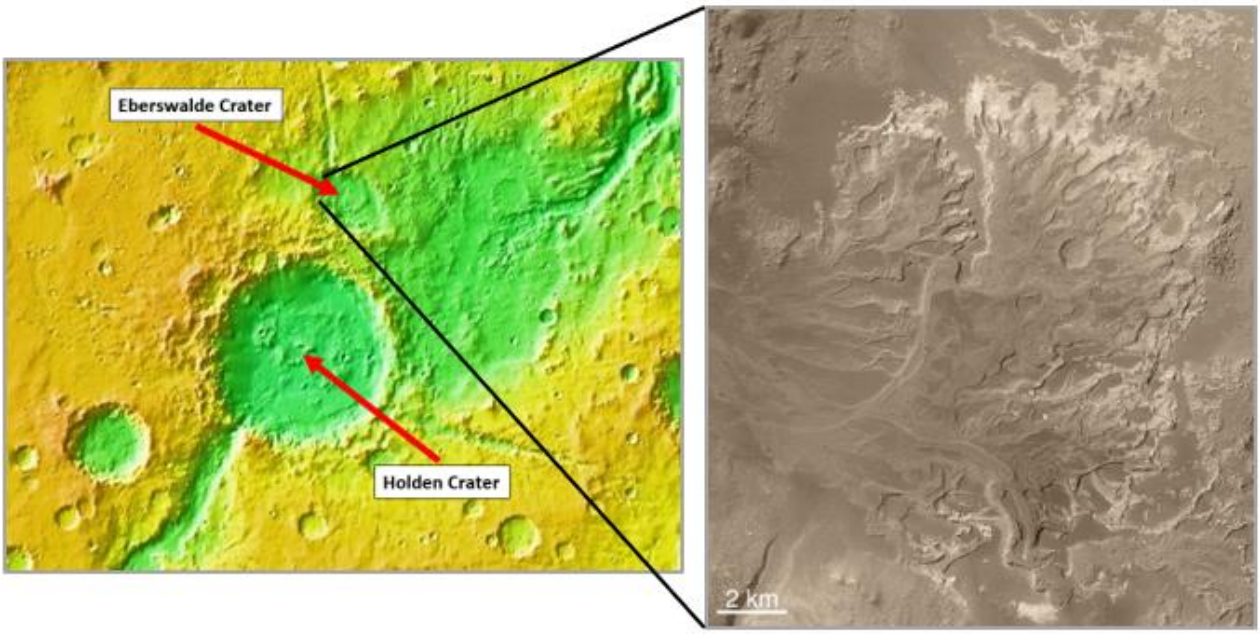


Figure 2: Left – An elevation map image showing the region around Holden Crater on Mars, with the smaller Eberswalde Crater to the north also labeled. Right – A zoomed high-res image of the Eberswalde Crater Delta on Mars that lies within Eberswalde Crater, showcasing patterns similar to those found in river deltas on Earth.

Part 3. The Tharsis Bulge on Mars

One of the things you've probably noticed on the Mars map so far is the large, smooth, elevated (red) region hosting several large volcanos (large white peaks), which is highlighted in Figure 3. This area is known the as the Tharsis Bulge, or Tharsis region, and is thought to have formed due to large internal magma intrusions deep inside Mars. You might have also noticed the large canyon on the right side of the Tharsis Bulge, this is known as Valles Marineris. The Tharsis Bulge also shows few craters and appears relatively smooth compared to the otherwise heavily cratered southern hemisphere.

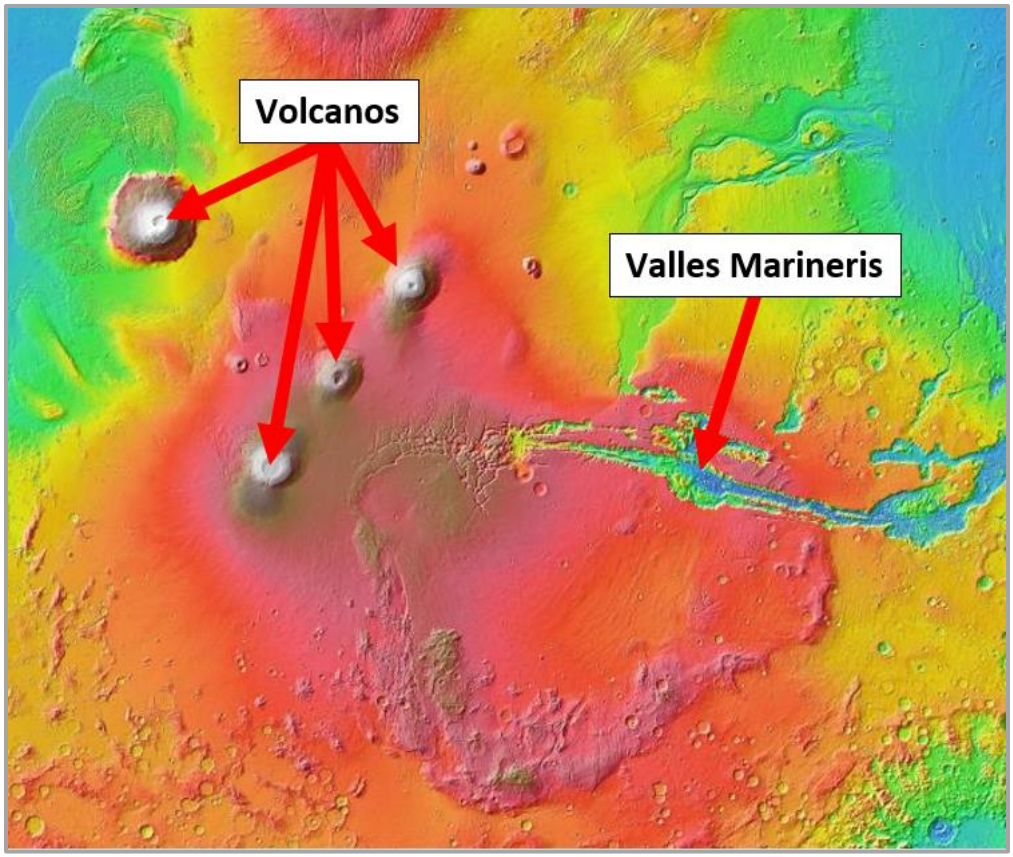


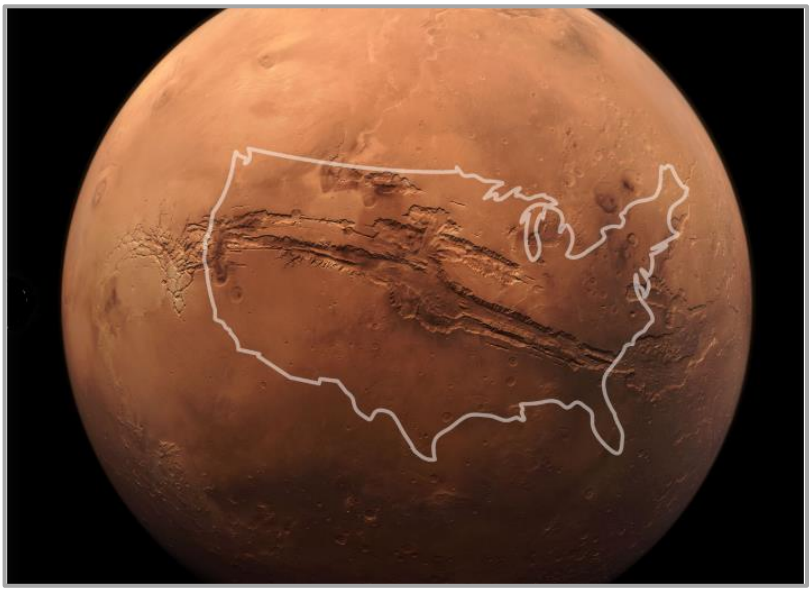
Figure 3: An elevation map image of the Tharsis Bulge on Mars, showing the red elevated region hosting many volcanoes and the large canyon known as Valles Marineris.

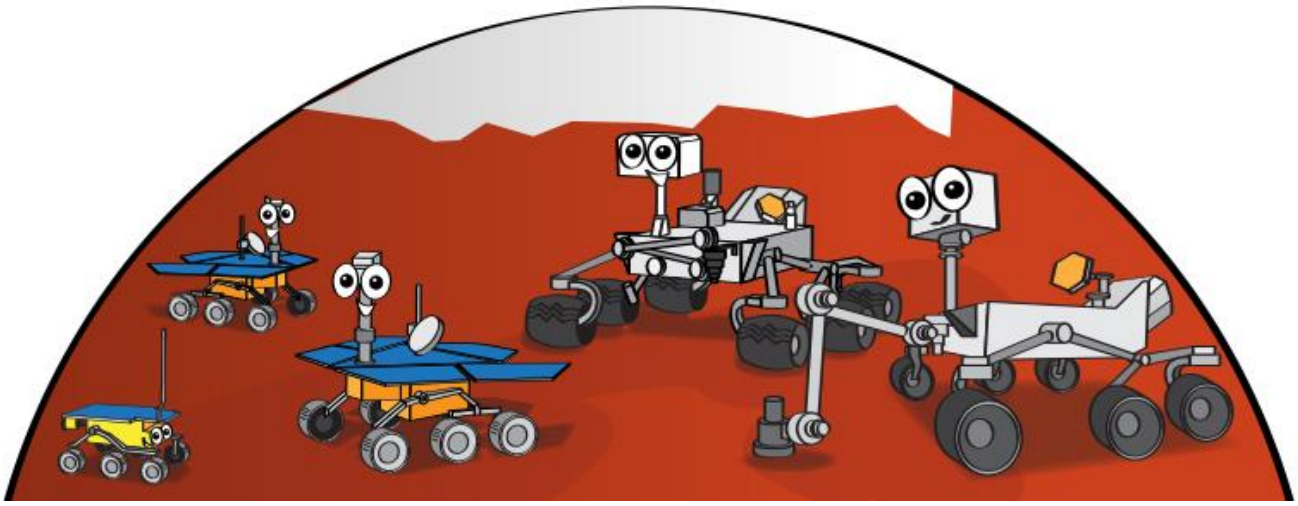
1. Given that we suspect these volcanos erupted large amounts of lava in the past, why do you think the Tharsis region is relatively smooth now and shows few craters? Explain your reasoning. (Hint: recall that fluids generally flow from high elevation to low elevation, and cooled lava becomes new surface material)

2. Visually compare the smoothness and number of craters between the northern and southern hemispheres of Mars. Keeping in mind your answer to the previous question, do you think the northern or southern hemisphere of Mars was more volcanically active in the past? Explain your reasoning.

3. Valles Marineris is thought to have likely formed as a large crack in the Tharsis region due to tectonic activity, potentially followed by erosion over time. Knowing this, and keeping in mind your answer to the previous two questions, do you think that Valles Marineris formed before or after most of the lava had already flowed from the Tharsis Bulge volcanoes? Explain your reasoning.

4. The Grand Canyon on Earth is around 446 kilometers long. Valles Marineris on Mars is around 4,000 kilometers long (nearly as long as the entire United States!). About how many Grand Canyons could fit end-to-end along the length of Valles Marineris? Show or explain your work.





5. Do you think Mars is a planet entirely inhabited by **robots**? Explain your thinking.

<u>To complete this assignment for grading:</u>

- File → Save As… → Rename the file 'YourLastName – MarsLab'
- Upload to the file to the 'Lab 8 – Landscapes of Mars' assignment in iCollege (click Add Attachments → Upload → upload renamed saved file → Update).
- Complete the Reflection activity on iCollege