Name:_____
Date:_____

15 Surface Water Flow Features on Mars

15.1 Introduction

In this lab you will be making measurements of some valleys and channels on Mars. The main goal of this lab is to be able to distinguish the different surface features left by small, slow flowing streams and large, rapid outflows. You will calculate the volumes of water required to carve these features, and consider how this volume compares with other bodies of water. Be sure to write down and turn in all of your measurements and work. **Write your name on all transparencies and staple them to your lab.**

15.2 Warrego Valles

The first three questions refer to the two images of Warrego Valles. One image is a close-up, the other a wider view. First, look at the close-up view and find the valley system. Look at the impact craters and determine which direction the sunlight is coming from. Warrego Valles is located in Mars' southern hemisphere; its location is identified on the Mars globe and map we have available for you to look at.

1. By looking at the morphology, or shape, of the valley, geologists can tell how the valley was formed. **Does this valley system have a dendritic pattern (like the veins in a leaf) or an anastomosing pattern (like an intertwined rope)? (2 points)**

2. Overlay a transparency film onto the close-up image and tape or paperclip the photo and transparency together so that the transparency does not shift. Trace the valley pattern onto the transparency (be sure to attach your transparency to your lab). **Does the shape of this valley point to slow formation over time or to fast formation from a localized water source? Why do you say this? (3 points)**

3. **Now, trace the boundary between the uplands and plains on your close-up overlay (the transparency sheet) and label the UPLANDS and the PLAINS.** (Again, be sure to attach your transparency.) **Is Warrego located in the uplands or on the plains? (5 points)**

4. Which terrain is older? Recall that we can use crater counting to help determine the age of a surface, so let's do some crater counting. *Attach a transparency sheet to the wide-view image.* Pick out two square regions on the wide view image, each 3 cm × 3 cm. One region should cover the smooth plains and the other should cover the cratered region. Draw these two squares on the transparency sheet. **Count all the impact craters greater than 1 millimeter in diameter within each of the two squares you have outlined. Write these numbers below, with identification. Which region is older? What does this exercise tell you about approximately (or relatively) when Warrego formed? (5 points)**

5. To figure out how much water was required to form this valley, we first need to estimate its volume. The volume of a rectangular solid (like a shoebox) is equal to $\ell \times w \times h$, where ℓ is the length of the box, h is the height of the box, and w is the width. We will approximate the shape of the valley as one long shoebox and focus only on the main valley system. Use the close-up image for this purpose.

   First, we need to add up the total length of all the branches of the valley. Measure the length, in millimeters, of each branch and the main trunk. Be careful not to count the same length twice. Sometimes it is hard to tell where each branch ends. You need to use your own judgment and be consistent in the way you measure each branch. Now add up all your measurements and convert the sum to kilometers. In this image 1 mm = 2 km. **What is the total length ℓ of the valley system in kilometers? <u>Show your work.</u> (5 points)**

Second, we need to find the average width of the valley. Carefully measure the width of the valley (in millimeters) in several places. **What is the average width? Convert this to kilometers.** Again, **show all of your work. (5 points)**

Finally, we need to know the depth. It is hard to measure depths from photographs, so we will just guess. From other evidence that we will not discuss here, the depth of typical Martian valleys is about 200 meters. **Convert this to kilometers. (5 points)**

Now find the total valley volume in km^3, using the relation $V = \ell \times w \times h$. This is the amount of sediment and rocks that was removed by water erosion to form this valley. We do not know for sure how much water was required to remove each cubic kilometer, but we can guess. Let's assume that $100\,\mathrm{km}^3$ of water was required to erode $1\,\mathrm{km}^3$ of Mars. **How much water was required to form Warrego Valles? (5 points)**

15.3 Ares and Tiu Valles

The remaining questions refer to Ares and Tiu Valles. On the wide scale image, Ares is on the right and Tiu is on the left (your instructor will show you which way to hold the images). The Mars Pathfinder *spacecraft landed in the top left region of this image in 1997. Can you guess why that particular spot was chosen? Again, look at the impact craters to get an idea of where the Sun is.*

6. First, which way did the water flow that carved these channels? The way to tell is to look at streamlined islands, like those on the second print. When flowing water erodes an island, it leaves a shape that has the smallest amount of drag possible. This same shape is used in things like cars and airplane wings. Think about these every-day shapes. **In the close-up photo, did water flow south-to-north or north-to-south? (5 points)**

   Find these same two islands in the large scale print (they are close to the top, left of center). Find other islands with the same shape elsewhere in the channel. *Tape or clip a transparency to your photo and make a sketch of the pattern of these channels.* **Now add arrows to show the path and direction the flowing water took.** Look at pattern of these channels. **Are they dendritic or anastomosing? (5 points)**

   Can you identify locations where the ground seems to have collapsed and the ground water poured out? These are called "chaos" regions because the ground surface appears to be a chaotic jumble. **Label these regions on your sketch and attach it to your work. (5 points)**

7. Now we want to get an idea of the volume of water required to form Ares (the right hand) Valles. Measure the length of the channel from near the Pathfinder landing site to the bottom right corner of the image. Also, measure the length of any tributaries that you see. In this image, 1 mm = 10 km. **How long is the channel in km? (5 points)**

   Measure the channel width in several places and find the average width. **On average, how wide is the channel in km? (5 points)**

   The average depth is about 700 m. **How much is that in km? (5 points)**

Now multiply your answers (in units of km) to find the volume of the channel in km^3. *Use the same ratio of water volume to channel volume that we used in Question 3 to find the volume of water required to form the channel.* **How does the volume of water required to form Ares Valles compare to the volume of water required to form Warrego Valles? (5 points)**

8. You have now studied Warrego and Ares Valles up close. **Compare and contrast the two different varieties of fluvial (water-carved) landforms in as many ways as you can think of (at least three!). Do you think they formed the same way? (10 points)**

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15.4 Take-Home Question

Answer the following question on a separate sheet of paper, and turn it in with the rest of your lab.

9. What happened to all of the water that carved these valley systems? We do not see any water on the surface of Mars when we look at present-day images of the planet, but if our interpretation of these features is correct, and your calculated water volumes are correct (which they probably are), then where has all of the water gone? Discuss two possible (probable?) fates that the water might have experienced. Think about discussions we have had in class about planets' atmospheres and what their fates have been. Also think about how Earth compares to Mars and how the water abundances on the two planets now differ. **If you have questions, please ask! (20 points)**