Cratering and the Martian Surface

Firstname Lastname

Date

1. Replace the red text at the top of this page with your name and the date.

2. As you enter your work, please make sure that your answers stay red (like this). This will make them easier to see, and thus it will be easier for us to grade them accurately. To convert black text to red, highlight it and then click on the “A” symbol in the menu bar above, to the right of the “**B**”, “*I*”, and “U” symbols. Select the red square to turn your highlighted text red.

3. Your instructor will ask you to include copies of your Martian field images with marked craters, and lists of marked craters, for some of the ten fields that you examine. Make sure that you know which field images to include, and remember to save the images as you create them.

4. Delete these 4 initial instructions from this template as soon as you have followed them.

Dating Volcanic Activity

1. Over the last billion years, there have been replace this text times fewer 500+meter impact craters than 250+ meter ones, and replace this text times more 63+ meter than 250+ meter ones.

2. A billion-year old surface should have replace this text times more 125+ meter impact craters than a million-year old surface.

3. The density curves for the smallest size craters are flat between four and one billion years, because there were so many impact events at that time that you couldn't incur one without rubbing out a former crater. Is the same trend true for 250+ and 500+ meter craters, and if not, why not?

Replace this text.

4. Hadriaca Patera

Mark all craters equal to or larger than 500 meters in diameter, and then use your measurement of the crater surface density and Figure 4.5 to derive an age for this surface. Justify your final answer, by showing your work for each stage of the problem and describing your intermediate results.

Replace this text.

5. Your age estimate for Hadriaca Patera is based on the density of craters equal to or larger than 500 meters in size. Why did we select that size limit for this image? We asked you to focus on 500+ meter craters because there are enough of them present in a field of this size and this age to give a statistically useful answer. How would your age estimate change if you studied craters down to a limit of 250 meters? Calculate a second age estimate based on these craters, and compare it to your first value. Do they agree?

Replace this text.

6. Pavonis Mons

Mark all craters equal to or larger than 63 meters in diameter, and then use your measurement of the crater surface density to derive an age for this surface. Show your work.

Replace this text.

7. Arsia Mons

Mark all craters equal to or larger than 63 meters in diameter, and then use your measurement of the crater surface density to derive an age for this surface. Show your work.

Replace this text.

8. Olympus Mons

Mark all craters equal to or larger than 16 meters in diameter, and then use your measurement of the crater surface density to derive an age for this surface. Show your work.

Replace this text.

9. Which crater field was the most difficult for you to mark, and which was

the most straightforward? Is there a connection between the terrain of the surface being sampled and the accuracy with which craters are identified? Does it matter how small the minimum target crater size is, or how well-resolved the image is (the size of the smallest physical structure which can be observed on it)?

Replace this text.

10. Consider the information given in the text, and Figures 4.3 and 4.4, and explore whether your age estimates for all four volcanic regions agree or disagree with the time line established for the three major epochs of Martian surface evolution.

Replace this text.

Dating Valley Networks and Outflow Channels

1. Nirgal Vallis

Mark all craters equal to or larger than 500 meters in diameter, and then use your measurement of the crater surface density to derive an age for this surface. Show your work.

Replace this text.

2. A crater is observed to cut through the Nirgal Vallis in the view of the

surrounding area, suggesting that this water-carved valley is (older / younger) than the crater. (Remove incorrect answers.)

3. Tiu Vallis

Mark all craters equal to or larger than 250 meters in diameter, and then use your measurement of the crater surface density to derive an age for this surface. Show your work.

Replace this text.

4. Warrego Vallis

Mark all craters equal to or larger than 500 meters in diameter, and then use your measurement of the crater surface density to derive an age for this surface. Show your work.

Replace this text.

5. Ares Vallis

(a) Mark all craters equal to or larger than 250 meters in diameter, and then use your measurement of the crater surface density to derive an age for this surface. Show your work.

Replace this text.

(b) Water flowed into this region from the (upper / lower) - (right - left) corner, and exited via the (upper / lower) - (right - left) corner. (Remove incorrect answers.)

6. Based on your estimates of the ages for these four water-carved surfaces, (valley networks / outflow channels) are older. Explain your answer. (Remove incorrect answers.)

Dating Water Floods Caused by Volcanic Activity

1. Dao Vallis

Mark all craters equal to or larger than 250 meters in diameter, and then use your measurement of the crater surface density to derive an age for this surface. Show your work.

Replace this text.

2. Cerberus Fossae

Mark all craters equal to or larger than 16 meters in diameter, and then use your measurement of the crater surface density to derive an age for this surface. Show your work.

Replace this text.

3. How do the ages of these two outflow channels compare to those studied in Section 4.5.1?

Replace this text.

Final (post-lab) Questions

1. Figure 4.8 contains images of four Jovian moons, all with thin atmospheres. Examine the images and then answer the following questions based on your observations.

(a) Sort the four surfaces from oldest to youngest. Why did you rank them in this order?

Replace this text.

b) Which moon(s) are most likely to be geologically active, and why?

Replace this text.

2. Create two histograms, each one counting the total number of craters in a single hemisphere. Do the two histograms support, contradict, or in no way relate to the hypothesis? Explain your reasoning. Make sure to label the axes of both plots, and to include appropriate figure captions.

Place two PNG-format figures here, and replace this text.

3. Could you distinguish between a billion-year old surface and a 3.5 billion-year old surface by counting the surface density of craters with diameters equal to or greater than 16 meters? If so, how? If not, why, and what simple change could you make to your approach to do so? What results (specific values for your measurements) would you expect for each surface?

Replace this text.

4. Figure 4.9 shows a portion of the caldera at the summit of Ceraunius

Tholus. You could derive an age for the surface by assuming that all of the craters were caused by impactors. If you then realized that half of them were interlopers (volcanic or collapse features), how would your answer change - would your derived age increase or decrease, and by how much? Explain your answer.

Replace this text.

5. (a) Describe a possible systematic bias which might affect the measurements of impact crater densities that you made in this laboratory exercise.

Replace this text.

(b) If you find four 63+ meter craters in a ten square kilometer field, what age would you derive for the area? If you found two in the adjacent ten square kilometers, what age would you derive from that field? What is the difference between your two estimates, in years?

Replace this text.

If you then expanded your field size and found 4,000 63+ meter craters in a ten-thousand square kilometer field and 3,937 in a neighboring field of the same size, what ages would you now derive, and what would the difference be, in years?

Replace this text.

What can you conclude about the importance of field size in determining surface ages?

Replace this text.

6. Which of these two models (gradual, or catastrophic processes) best explains the formation of Martian valley networks, and which best explains the formation of Martian outflow channels?

Replace this text.

Summary (300 to 500 words)

Replace this text.

Extra Credit

Replace this text.