LANDSCAPES OF MARS

8

OBJECTIVES

After completing this exercise the student should be able to:

1. identify major features on Mars.
2. determine relative ages of surface features by superposition.
3. determine relative ages of features by using crater density.

STUDENT MATERIALS

pencil

LAB MATERIALS

Each lab setup needs:

- Mars map or globe,
- access to http://www.google.com/mars/

STUDENT REQUIREMENTS

Students may work with a lab partner. All questions are to be answered individually, using your own words. Turn in the answers to all questions.

INTRODUCTION

From spacecraft photography and mapping of planets it is possible to determine the relative ages of surface features on some planets such as Mars. In other words they help determine whether a canyon or volcano was formed before or after some cratering events for that planet. Unfortunately this method of relative dating cannot determine the actual age of the feature. Thus these techniques cannot tell an astronomer if a canyon is one million or one billion years old. The actual dating of craters, volcanoes, etc., can only be done through radioactive age dating. In practice, this has only been done for Earth and moon rocks brought back by the Apollo astronauts.

Superposition is a method of determining the relative ages of features. If one feature is on top of or partially obliterates another feature it must have formed after the feature it was superimposed upon it.

Crater density is another important method used to estimate the age of one landscape relative to another landscape. This method is based on a theory of solar system creation in which the number and size of meteoroid and asteroid material decreases in both number and size with time. This implies that landscapes which have large numbers of big and small craters were created early in the solar system's formation period when the amount of meteoroid and asteroid material available to form impact craters was high. As time passed, the quantity of this material decreased. Landscapes which formed later in the solar system's development have smaller and fewer craters per square kilometer than those which formed earlier. Thus by counting the number of craters within two areas of equal size the relative ages between these areas can be determined. The one with the largest and most craters can be considered to be the older landscape.

In the lab you will use superposition and crater density to estimate the relative age of several Martian landscapes.

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PROCEDURE

1. At a computer open http://www.google.com/mars/ (Google Mars). Google Mars opens with north at the top and south at the bottom. The equator of Mars runs left and right through the middle of the Google Mars map. East is on the right and west is on the left. An odd feature of Google Mars is the as you move the map to the east or west it simply repeats itself over and over. This does not happen as you move the map north and south. Take a few minutes to explore around in the Google Mars site. Be sure to examine Mars using the elevation, visible, and infrared maps provided on Google Mars. Also click on the various regions listed in the upper left corner of the Google Mars home page. When you click on a region you can then click on the buttons that appear on the map for more information. Have fun exploring another world as you do this.

2. You have probably noticed that the northern hemisphere of Mars is very volcanic and the southern hemisphere is heavily cratered. Using the concept of crater density which hemisphere do you think shows the oldest landscape?

   Northern or Southern _____

3. Inspect the Mars globe or map provided in class and locate two basins in the southern hemisphere. Argyre Planitia, is near longitude 40° and latitude –50° and Hellas Planitia, is near longitude 290° and latitude –40°. These two basins were probably formed by giant impacts of meteoroids. The smooth surfaces at the bottom of these two large craters are lava flows. Use Google Mars and try to determine if you think these lava flows occurred before or after most of the bombardment and cratering activity of the early Solar System? (Hint: Use carter density around the outside of the two craters and inside them.)

   before or after _____

   Why?

4. Use Google Mars to inspect the rim of Argyre Planitia and Hellas Planitia. Look to see if the rims have more craters than the lava flows inside the rim. Look for evidence of ghost craters which have been filled with lava. Based upon the appearance of the rims, which of the following historical accounts is most likely? Circle your choice, **a** or **b**.

   a. These giant impacts occurred early, when most of the other impacts occurred, and excavated the large basins with their surrounding rims. The lava filled the basins much later after most of the cratering activity was over.

   b. The giant impacts just happened to occur very late after most of the other craters had formed and the lava filled the basins immediately after their formation.

   State what evidence you used in making this decision.

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5. Look carefully at the crater density along the rim of Hellas and Argyre. The basin that is older should have more craters on top of its rim than the younger one. Does the Hellas or Argyre basin look older?

   _____

   Why?

6. Most to the volcanoes on Mars look like mountains with a crater on their tops. These are not impact craters but instead are volcanic craters. Use Google Mars to estimate how many volcanoes you can identify on Mars.

   Number of Martian volcanoes you found is about _____.

7. After you have found the volcanoes on Mars use your Mars globes or maps provided in class and list the names of as many of these volcanoes as possible.

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8. Using the elevation color codes on Google Mars and possibly your globe of map name the volcanic feature that has the highest elevation, or is the tallest.

9. If you were to count craters on near these volcanoes would you be able to infer the age of the volcanoes relative the surrounding plains?

   Explain why or why not:

The Tharsis Bulge and Valles Marineris are thought to be caused by internal magma intrusions deep inside Mars (tectonics).

10. Inspect the area south of the Valles Marineris, between longitudes 45° and 100°. Notice that this area is not uniformly cratered or wrinkled. A boundary seems to occur at what longitude? _____

    Is the younger surface to the east or west of this boundary? _____

11. Look at the smooth plain named Tharsis Montes. Does the crater density suggest that Tharsis Montes is older, younger, or about the same age than the region south of the Valles Marineris? _____

13. Along the north rim of Valles Marineris is a place called the Candor Chasma Rim. It can be located in the canyon regions of Google Mars and is near the coordinates longitudes 70° and 75° and between latitudes –3° and –8°. Does this area suggest that the canyon is older or younger than the plains to the north and south?

    _____

14. Carefully look at the rims of Valles Marineris. Is there anything along the north or south rim that shows evidence of flowing water on Mars.

    yes or no?

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15. Look at the crater density inside the Valles Marineris on map and choose one of the following historical accounts of the canyon's formation.

    a. The canyon formed before the surrounding plains, and the lava flows which made the plains did not reach the canyon.

    b. The canyon was cut into the rock by a river of lava from the nearby volcanoes.

    c. The canyon forms a boundary between two plains of different ages.

    d. The plains formed first and at one time covered the entire area. Valles Marineris form later from an unknown cause.

16. Look at area around the volcano Arsia Mons. Using a magnified image locate several ridges or channels on the side of Arsia Mons. Make sure these channels were made by the volcano. Follow these structures to see if they extend out onto the surrounding plains at its base. Look carefully for any evidence that Arsia Mons has been partially covered by some other geological development.

    From this study choose one of the following historical accounts.

    a. The volcano formed first and was later buried by a lava flow from another volcano.

    b. The volcano formed the plains from its own lava flow and thus the plains and the volcano have the same age.

    Why do you think so?

17. On the Google Mars map click on the region labeled canyons. Below list any canyons that show evidence of flowing water on the surface of Mars.

18. Even though the atmosphere of Mars is $1/100^{th}$ of the Earth's atmosphere it is still enough to have wind that creates dunes. On Google Mars open the dunes region list. Look at the pictures of the Martian dunes. Are the dunes mostly out on the open plains, inside craters, inside canyons, or randomly placed? Why do you think so?