WHERE IS THE OLDEST SURFACE ON MARS?

ACTIVITY C-15

GRADE LEVEL: 4-12

Source: This activity was written by a team of scientists and educators (led by Carol Stadum) as part of the Mars Link program, sponsored by the Planetary Society. It has been slightly updated and adapted for this notebook by the staff of Project ASTRO. The activity is © copyright 1996 by the Planetary Society, 65 N. Catalina Ave., Pasadena, CA 91106. While the Mars Link booklet is now out of print, some of the materials can be found on the Society's web site at: planetary.org.

What's This Activity About?

Every solid body in the Solar System shows evidence of cratering — being hit by smaller bodies over the course of time. This activity explores how scientists can use the number of craters on a given surface as an indicator of the "age" of that surface (the time since it was last re-surfaced).

What Will Students Do?

Students simulate cratering with water dropping from a height onto a surface of fine sand. Students can see how surfaces change with time as more and more impacts occur. They compare the "cratered surfaces" they produce with pictures of the surface of Mars. They can extend their understanding by examining a more complex Mars image and then applying what they have learned about Mars to the analysis of the surfaces of other worlds.

Tips and Suggestions

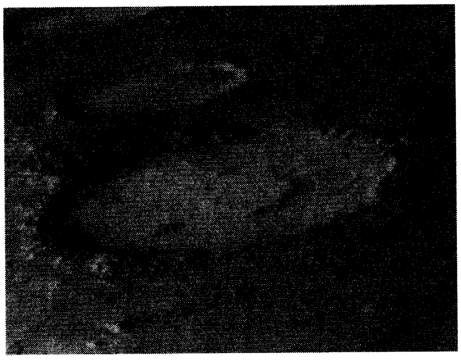
- It is very useful to try this experiment yourself before asking the students to do it. This makes sure that you have the technique down, and can advise the students if they run into trouble.
- Try varying the height of the ring stand and screen to see how the speed of the water droplets changes at impact, and how that affects the size of the craters.
- Try changing the type of terrain by using different surfaces—cat litter (which is very water absorbent) or powdered sugar covered by powdered chocolate (which might be able to show the kind of crater "rays" seen on the Moon).
- The images on Worksheet 2 are on the Web at: www.msss.com/education/marslink2000. Printing them out directly may give you better copies than photocopying Worksheet 2.

What Will Students Learn?

Concepts
- Crater formation
- Estimating the ages of planetary surfaces
- Erosion and flooding

Inquiry Skills
- Experimenting
- Observing
- Comparing
- Counting
- Inferring
- Explaining

Big Ideas
- Models
- Interactions
- Patterns of Change
- Simulations
- Scale
- Structure



The crater Galle on the eastern flank of the large Argyre basin in the southern hemisphere of Mars has some formations in it that look a bit like a "happy face." Galle is about 215 km across. *(Malin Space Science Systems)*

WHERE IS THE OLDEST SURFACE ON MARS?

by Carol Stadum, Ken Edgett, and the Mars Link Team
at the Planetary Society

Purpose

Students will discover that the longer the solid surface of a planet or satellite (moon) is exposed to impacts, the more craters it will have. Students will see that measuring the number of craters on a surface is a critical tool that geologists and planetary scientists use to unravel the history of the Solar System.

Objectives

1. Create simple cratered surfaces over different lengths of time
2. Discover that the oldest surface has the most craters
3. Compare their models with three surface images of Mars and place these images in order from youngest to oldest
4. Think about events that could make a surface on a planet half-cratered and half-smooth

Materials

- The student worksheets, one with Mars images
- Fine silica sand
- Screen squares for each group (about 10 cm x 10 cm) cut from metal window screens
- Ring stands for each group
- Petri dishes for each group
- Spray bottle with water for each group
- Plastic knife for each group
- Watch with a second hand or second counter for each group

Engagement

This activity is best done after you have an introductory discussion about the planet Mars (or the terrestrial planets in general). You may want to show a video or some slides about Mars so that students become a little bit familiar with its general landscape and surface properties. (If your class has access to the web, excellent images of Mars can be found at the Planetary Photojournal web site, at http://photojournal.jpl.nasa.gov.) Then begin by asking students to consider how one could use pictures of Mars to determine the how old various parts of its surface are.

Exploration 1

You may want to demonstrate the laboratory setup and experiment in front of the class before students begin their own explorations. Students should have paper and pen ready to record the changes in the sand surface over time in the data table on Worksheet 1. Divide students into small groups and let them divide up the different tasks:

- the sprayer, who sprays the mist
- the counter, who counts the "craters"
- the time-keeper, who monitors the time
- the recorder, who writes down the information in a data table

You or the students should put the fine sand into the petri dish, and place the screen at least one meter above the sand. Students begin the experiment by spraying a fine mist of water onto the screen, taking care NOT to spray the water with force. As soon as drops of water begin falling onto the sand, the counter should begin calling out the number of craters and the time-keeper should begin counting the seconds. After three seconds, students should remove the dish from under the screen and finish getting a good count of the number of drop "craters." Record the count on the data table and label it "3-second count." Does the sand resemble any of the images of Mars on the worksheet?

Now students should replace the sand under the screen and continue misting for another three seconds. After the three seconds are up, they should gently remove the dish and count the number of craters again. Label this number "6-second count" on the data sheet. Does the sand now resemble any of the Mars images on Worksheet 2? Students may want to make a rough sketch of the appearance of the sand at this point before going on.

Students should then carefully return the sand under the screen and mist the screen for another 3 seconds. Gently remove the sand and count craters again, labeling the result the "9-second count." Does the sand at this point resemble any of the Mars images?

Discussion 1

Based on the data they took and what the sand looked like at each stage, encourage students to discuss some or all of the following questions:

1. How did crater numbers and shapes change over time?

   > The more time passes, the greater the number of craters. Crater shapes are worn away as more drops fall, and new craters form over older ones.

2. Are the craters clustered together?

   > The answers will vary depending on how slowly and carefully students spray the mist on the screen.

3. How much time did it take for the craters to begin to overlap?

   > The answers will vary for different experiments. Eventually, as enough drops fall, students will begin to see overlapping craters, where older ones are covered (and eroded) by newer ones.

4. Which is older, a surface with many craters or just a few?

   > A surface with many craters has been exposed to "drops" from space longer, and is thus older.

5. How does crater density change with time?

   > The more craters we see on a surface, the older it is. (Note that surfaces can sometimes be smoothed over by lava floods or other processes that erase craters; we will discuss this issue in Exploration 2, which follows.)

6. What processes make craters on the terrestrial planets?

   > Impact craters are made when pieces of rock and ice from space hit the surface of these worlds, exploding on impact and making a crater.

7. If we continued to mist the screen and cause drops to fall for 5 minutes, what would the sand surface look like?

> The surface would be rough and bumpy and would have few distinct craters.

8. Which of the three images on the student work sheet shows the youngest surface? Which of the images shows the oldest?

> The more cratered the surface, the older it is.

Exploration 2

Now students should take the plastic knife and smooth off half of the heaviest cratered sand surface. This represents events that geologists call "re-surfacing." Ask the students to consider what kinds of natural processes on a planet might lead to such a re-surfacing event.

Discussion 2

9. What kinds of processes might lead to the re-surfacing of a planet or large satellite?

> The answer will vary from world to world. Lava floods and volcanic eruptions, erosion by wind or water (where these are a factor), landslides, tectonic forces (movements of the world's crust), and heavy periods of bombardment may all play a role.

10. When geologists use crater counts to date a particular section of a planet or moon's surface, what age are they measuring?

> Crater counts can only tell us the rough time since the last major re-surfacing event. Such resurfacing events will typically destroy the craters that were there before.

11. Look at Image D on student Worksheet 2. What might have shaped the surface shown in this image?

> Image D shows Pickering Crater on Mars, in a terrain that is half cratered and half smooth. Here we see an older surface next to a newer one. The smooth half must have been re-surfaced by erosion or lava floods. However, the rims of the larger craters have not been completely covered by the re-surfacing event and "emerge" from the lava plains, bearing silent witness to the dramatic process that covered the surface all around them.

EXTENSION ACTIVITIES

- If you have a globe or map of Mars, have students determine which parts of the planet look the youngest and which look the oldest.
- Have students focus their attention on Mars' polar ice caps. Are there many craters found there? Why not? Do rocks from space hit the polar regions? If so, what happens to the craters they make as time goes on?
- Ask students to discuss why pictures of the Earth from space show so many fewer craters than pictures of the Moon or Mars.
- Examine pictures of the Moon or the planet Mercury. How do the surfaces of these two worlds look, compared to Mars or Earth? On which worlds has there been more time since the last major re-surfacing?
- Examine radar maps of Venus constructed from data provided by the *Magellan* spacecraft. How does the surface of Venus compare to that of Mars, Earth, or the Moon?

WHERE IS THE OLDEST SURFACE ON MARS – WORKSHEET 1

Name: ______________________________

Date: ______________________________

In this experiment you will be using water droplets falling into fine sand to show how craters form on the surfaces of planets and moons. When you follow the instructions, be sure that:

- you use a fine mist on the screen and don't spray water with too much force
- divide up the work among members of your group and that everyone knows his or her task
- you don't allow too much time before you pull the sand out from under the drops

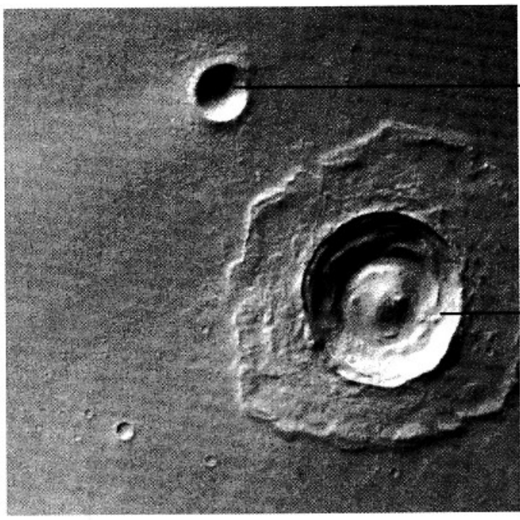
Data Table

Number of seconds the mist droplets fell	Number of craters counted

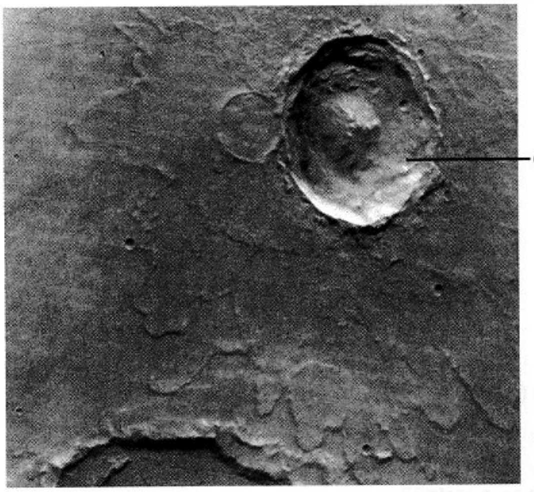
QUESTIONS TO DISCUSS:

1. How did crater numbers and shapes change over time?
2. Are the craters clustered together?
3. How much time did it take for the craters to begin to overlap?
4. Which is older, a surface with many craters or just a few?
5. How does crater density change with time?
6. What processes make craters on the terrestrial planets?
7. If we continued to mist the screen and cause drops to fall for 5 minutes, what would the sand surface look like?
8. Which of the three images on the student worksheet shows the youngest surface? Which of the images shows the oldest?
9. What kinds of processes might lead to the re-surfacing of a planet or large satellite?
10. When geologists use crater counts to date a particular section of a planet or moon's surface, what age are they measuring?
11. Look at Image D on the student worksheet 2. What might have shaped the surface shown in this image?

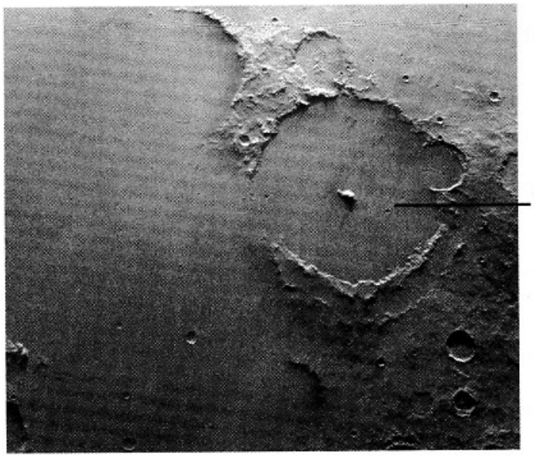
WHERE IS THE OLDEST SURFACE ON MARS – WORKSHEET 2



Two impact craters on Mars, a simple one at the upper left (labeled A) and one with a blanket of ejected material at the lower left (labeled B).



Crater Yuti (18 km in diameter), labeled C, north of Ares Valley.



Cratering Pickering (about 115 km across), labeled D, located in southwestern Daedalia Planum, has been partially breached and flooded by lava flows. *(Viking images; NASA)*