LESSON FOUR MAPPING MARS

GEOLOGIC SEQUENCE OF CRATERS AND RIVER CHANNELS

About This Lesson

Students will approach studying the surface of Mars in the same way as photogeologists. After drawing a simple features map, they will have the tools to state the general geologic history of a part of Mars' surface. Students focus on the evidence showing river channels that once flowed and caused erosion. The evidence for water and volcanoes (see Lava Layering) on Mars points to possible environments where life could have existed.

Objectives

Students will:

- observe photographic details.
- make a simple features map.
- interpret the geologic history of a part of Mars' surface.
- analyze and discuss sequencing.

Background

Scientists use maps to illustrate the geologic history of a planet or moon. Geologic maps show present day features and evidence of past events. The maps show features that were formed earlier or later than others, giving scientists a relative time sequence of events (not precise dates). On Earth these maps are made using photographs taken from airplanes and spacecraft, and from research on the Earth's surface. To make maps of other planets we must use photographs taken by spacecraft and use lander information from the planet's surface.

Vocabulary

crater, ejecta, eroded, channel, sun angle, sequence, Chryse Planitia (cry´ se̅e̅ plän ĭ´ tiə)

Materials - For activity using paper photos

- ☐ photo of Mars surface showing outflow channels emptying into northern plains of Chryse Planitia. Photo available on the World Wide Web at:
  http://lpi.usra.edu/expmars/channels.html
- ☐ Student Sheet, *Mars Mapping* (pg. 31)
- ☐ tracing paper or transparencies, one per paper photo
- ☐ tape or paper clips
- ☐ colored markers (3 colors - red, green, and blue are used in the discussion below)

Materials - For group version using slide

- ☐ slide projector
- ☐ large sheet of paper (not shiny) or a non-shiny erasable white board may be used — test first
- ☐ masking tape
- ☐ slide of Mars surface showing outflow channels emptying into northern plains of Chryse Planitia. Slide # 24 "Outflow Channels Emptying into Northern Plains of Chryse Planitia" in the Set THE RED PLANET: A SURVEY OF MARS

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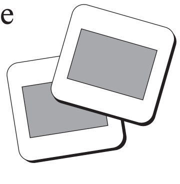


Note: A high quality transparency from a photo developer works well. Use the slide to make the transparency. Project with classroom overhead projector.

Procedure

Advanced Preparation

1. Gather materials.
2. Become familiar with the important features in the Mars photo.
3. Practice determining the up and down slopes of the features by paying attention to the Sun illumination angle and the shadows on the features.

Procedure for Paper Copy of Photograph

Steps below are for individuals or pairs using a paper copy of the Mars image.

1. Secure a transparency or sheet of tracing paper to the top of the Mars photo.
2. Distribute materials.
3. Tell students that this is a spacecraft photograph of an area on Mars around 20° N latitude and 55° W longitude, at the northern edge of Chryse Planitia. The image shows impact craters and river channels. The area is about 200 kilometers across. No one has ever been there, but we can figure out things about this part of Mars by mapping and thinking.
4. Show students an example of a crater with a continuous, sharp-edged, unbroken rim. Note that they should draw the rim and not the fairly flat interior (see drawing on student sheet).
   If time and skill allow, students may also note and draw the ejecta for the fresh sharp rimmed craters. The ejecta is the material that is blasted out of the crater and falls outside the rim of the crater. The ejecta is usually more irregular than most of the craters. **Review with students how to tell what is a depression and what is a hill slope by knowing the direction of illumination from the Sun.**
5. Have students carefully outline the **rims** of all sharp-edged craters red.
6. Show students an example of a crater with an uneven, eroded, broken rim (see student sheet).
7. Have students carefully outline the **rims** of all eroded craters green.
8. Show students an example of a river channel.
9. Have students color (not outline) all channels blue. They may try to show both sides of the channel but a single line in the middle of the channel is adequate.
10. Have students lift the transparencies and look at them. Ask the student what they have made. **(They have made a simple feature map.)**
11. Answer and discuss the questions on Student Sheet.

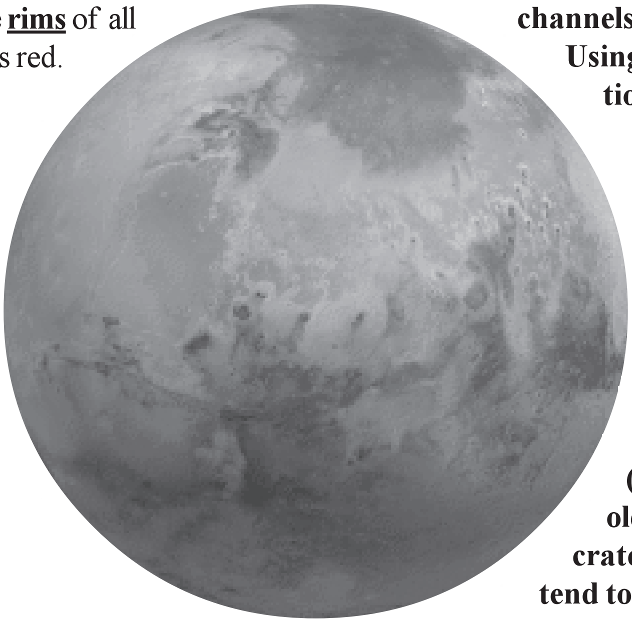
Group Procedure Using a Slide

Steps below are for a large group activity using a slide.

1. Tape a large sheet of paper to the wall.
2. Project the slide on the paper, so the image is as large as possible.
   Be aware that it will be easier to clearly distinguish details on the image from several feet away due to projector focusing. When students draw on the paper they will either need to ask for some help from classmates or step back frequently. This leads to a good cooperative activity.
3. Tell students that this is a spacecraft photograph of an area on Mars around 20° N latitude and 55° W longitude, at the northern edge of Chryse Planitia. The image shows impact craters and river channels. The area is about 200 kilometers across. No one has ever been there, but we can figure out things about this part of Mars by mapping and thinking.
4. Show students an example of a crater with a continuous, sharp-edged, unbroken rim. Note that they should draw the rim and not the fairly flat interior (see drawing on student sheet).
   If time and skill allow, students may also note and draw the ejecta for the fresh sharp rimmed craters. The ejecta is the material that is blasted out of the crater and falls outside the rim of the crater.

The ejecta is usually more irregular than most of the craters.

5. Have a student or group of students carefully outline the **<u>rims</u>** of all sharp-edged craters red.
6. Show students an example of a crater with an uneven, eroded, broken rim (see Student Sheet).
7. Have students carefully outline the **<u>rims</u>** of all eroded craters green.
8. Show students an example of a river channel.
9. Have students color (not outline) all channels blue. They may try to show both sides of the channel but a single line is adequate.
10. Turn off the overhead projector and ask the students what they have made. **(They have made a simple feature map.)**
11. Answer and discuss questions on Student Sheet.



<u>Questions and Answers</u>

1. Which are older - river channels or green craters? How do you know? **Green craters are older. When a river channel met a green crater the water broke through the rim, entered the crater, broke out somewhere else, and kept going.**

2. Which are older - river channels or red craters ? How do you know ? **River channels are older. When an impact formed a red crater on top of a river channel the crater covered the channel, but the crater was not eroded. The river had stopped flowing.**

3. Which features are oldest, youngest, and of medium age? **Green craters are oldest, red craters are youngest, river channels are of medium age. Using the data from questions 1 and 2, the green craters were there before the channels, and the channels were there before the red craters.**

4. Are big craters older or younger than small craters? **Big (green) craters are older than small (red) craters. The green craters tend to be larger while the red ones are generally smaller. The same observation that the green craters were there before the channels and the red craters were formed after the channels sets the larger green craters as being older.**

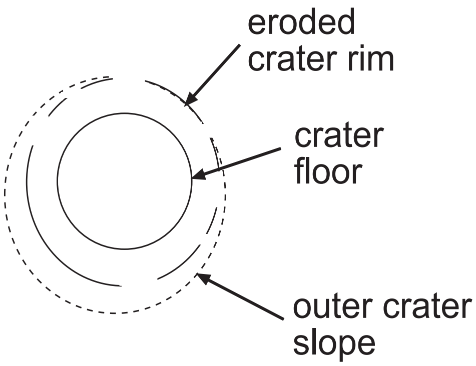
5. Write a simple geologic history of this part of Mars. **First large meteorites hit the surface and made big craters. Later flowing water formed river channels which cut through some of the old craters. After a while the rivers stopped flowing. Even later smaller meteorites hit the surface. Some of these formed craters on top of the dry channels and on older craters.**

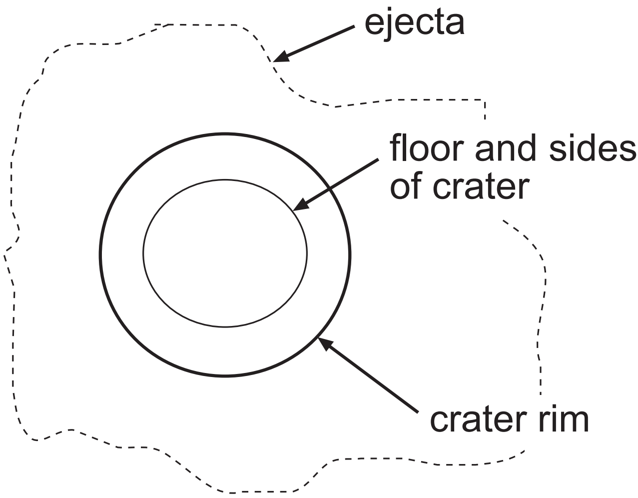
<u>Extra credit</u>

6. What caused the difference in size between the young craters and the older craters? **Most of the big meteorites hit a long time ago. Later only smaller meteorites were left. The earlier meteorites were very large pieces of planetary material that**

were still being pulled together through the process of solar system accretion (gathering of material into planetary bodies). As time passed, the impacts were caused by the smaller pieces of material leftover from the accretion process, thus making smaller craters.

7. Which way does the land slope? **The land slopes downwards from the west to the east. River channels combine as you go downhill. A map of the Mississippi River or some other terrestrial river basin may be used as a comparison. These Mars channels do not show a delta formation as some may suggest.**





STUDENT SHEET

MARS MAPPING

Objective

To make a simple features map and interpret the geologic history of a part of Mars' surface.

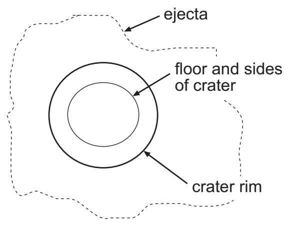
Background

Scientists use maps to illustrate the geologic history of a planet or moon. Geologic maps show present day features and evidence of past events. The maps show features that were formed earlier or later than others, giving scientists a relative time sequence of events, although not precise dates. On Earth these maps are made using photographs taken from airplanes and spacecraft, and from research on the Earth's surface. To make maps of other planets we must use photographs taken by spacecraft and use lander information from the planet's surface.

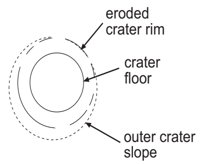
The area in the photograph of Mars is about 200 kilometers across and shows impact craters and river channels. Mark these features on the photograph using the examples below. Then answer the questions on the back of this page.

Features found in the photograph are:

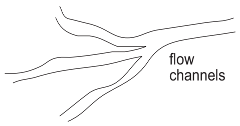
1. Craters with continuous, sharp-edged, unbroken rims.
   Carefully outline the rims all such craters **Red**.



2. Craters with uneven, eroded, broken rims.
   Carefully outline the rims of all such craters **Green**



3. River channels.
   Color (not outline) all channels **Blue**.



Questions

Use the map to answer the questions.

1. Which are older — river channels or green craters? How do you know?

2. Which are older — river channels or red craters? How do you know?

3. Which features are oldest, youngest, and of medium age?

4. Are big craters older or younger than small craters?

5. Write a simple geologic history of this part of Mars.

Challenge

What caused the difference in size between the young craters and the older craters?

Which way does the land slope?

MAPPING MARS KEY

A = sharp-edged crater B = eroded crater ★ = crater wall as seen in sunlight