Impact Craters

Suggested Grade Level: 3–6

Summary

1. Students will model impact cratering.
2. Students will examine what happens to the surface upon impact.
3. Students will experiment with different materials.

Standards

- NM Science Content Standards: Strand II, Standard III, Earth and Space Science
- National Science Standards: Content Standard D, Earth and Space Science; Content Standard G, History and Nature of Science

Background Information

Impact cratering is one of the dominant geological processes altering the surfaces of all of the solid-surface planets in our solar system. Impact craters are formed when objects such as meteorites, comets, or debris from asteroids impact the surface of a planet. Impact craters excavate (dig) holes into the surface and sometimes bring material up to the surface that would otherwise be hidden beneath the surface. The size and depth of the crater are directly related to the size and mass of the object that hits the surface. Impacts of different sizes happen at a statistical rate over a given time period, so you can use the number of impact craters on a planetary surface to tell which part of the planet's surface is older (more impact craters) and which part of the surface is younger (fewer impact craters). This concept is similar to the wear and tear on city streets. Smooth streets have usually been repaved (planetary geologists used the word resurfaced) recently and represent younger surfaces within the city; rough streets with many potholes have not been recently resurfaced and represent older surfaces within the city.

Impact craters of different sizes show different topography. In general, small impact craters are simple bowl-shaped craters. As impact craters increase in diameter, the bowl-shape becomes flat-bottomed and the walls have terraces. Large craters have a central peak and very large craters (sometimes called impact basins) show one or more rings of peaks within the crater wall. A very distinctive type of impact crater ejecta on Mars looks like a rock tossed into a mud puddle. These impact craters are believed to represent impact into a region with ice beneath the surface.

Materials

1. Images of Martian impact craters, included in the activity
2. Impact Craters! Mission Investigation Log booklet, included in the activity
3. Balls (meteorites) of different sizes and materials; they should be in small, medium, and large sizes made from foam, glass, plastic, rubber, or other similar materials that differ in mass.
4. Three yardsticks or metersticks.
5. Mats or other floor-protection for beneath and around the boxes.
6. Three large but shallow boxes or three large but shallow plastic tubs without the lids or three large kitty litter trays.
7. Three different types of material, kitty litter, sand, and sawdust, in sufficient quantity to cover the bottom of the box or tub to a depth of about 3 inches (7 cm).
8. Flour, cocoa, or ground coffee and a flour-sifter or slotted spoon.

Preparation

1. Print the Mars impact crater images included in the activity. To assemble the booklet, print and/or photocopy Pages 8 and 9 of this activity in double-sided format (or print each page single-sided and staple or tape them back to back), and fold in half.
2. Set up the three boxes or tubs with mats beneath them to protect the floor and fill each box to about 3 inches (7 cm) with one of the three materials.
3. Use flour, cocoa, or ground coffee and a flour-sifter to add a thin contrasting colored coating to the surface of the material in the boxes. The teacher or the student teams should replenish this coating before each team begins to experiment with each box.
4. Provide a range of ball sizes and materials for each box. Provide a small can or plastic container of flour, cocoa, or ground coffee and either a flour-sifter or slotted spoon for each box. Provide a yardstick or meterstick for each box.

Introduction for Students

Craters on planets are formed by the impact of meteorites, comets, or asteroids. These impact craters and their ejecta (the material that they excavate and bring to the surface) can tell geologists about the rocks of a planet. Some geologists specialize in studying impact craters and produce their own small impact craters as experiments in order to understand these important craters. Your team will experiment with impact craters like those found on the surface of Mars. Drop balls of differing sizes and materials onto the surface from different heights, keep track of your experiments and data, and examine what happens to the surface upon impact. Use the letters of features listed on the back of your Data Sheet booklet and fill in the data charts for each type of surface.

Procedure

1. Have students work in teams and rotate the teams so that each team works with all three boxes. Each team should have a scribe that keeps track of their experiments and results on the Data Sheet booklet.

2. Discuss impact craters and crater features with your students.

3. Using the yardstick or meterstick, have the students drop balls of different sizes and materials on to the surface from different heights (for example, from 12 inches, 24 inches, and 36 inches).

4. The students should make observations about what happens to the surface upon impact.

5. Use the letters of features listed in the booklet to fill in the charts for each surface.

6. Have each team try each surface and compare the results.

7. Show students the Mars impact crater images and compare them with the model impact craters they have produced.

Process/Closure

Can you describe the material beneath the surface based on the craters you have made? Hint: as the crater is formed, the surface material is actually overturned and creates a pattern of ejecta around the crater where the deeper material excavated is brought up and over to lie on top of the surface. If you have a large and deep enough crater, you will bring material from deep beneath the surface up to the surface.

What can you say about different size/mass balls and the three different surfaces? Which balls created the largest, deepest craters? What material allowed for the creation of large, deep craters? Why?

Extension/Enrichment

1. Compare the experiment results with images of Mars impact craters included in the activity. Look at a map or globe of Mars showing the northern hemisphere and the southern hemisphere of Mars. Can you tell that the northern hemisphere has fewer impact craters and therefore is younger?

2. Continue your experiments by adding water to the box with sand in it and see if you can create impact ejecta patterns around the crater that are similar to those formed around these mud-puddle type craters on Mars.

3. Continue your experiments by using other materials to fill additional boxes.

Credits

This activity was adapted by Amy Grochowski and Jayne Aubele, New Mexico Museum of Natural History & Science, from the following impact crater activities: Mud Splat Craters, Mars Activities: Teacher Resources and Classroom Activities; Creating Craters, Passport to Knowledge, Live from Mars, Activity 3.2; and Making Craters, Beakmans World on Tour.

MARS FACTS

Mars days are called sols to distinguish the 24-hour-and-37-minute Mars day (one revolution around its own axis) from that of the 24-hour Earthday. During an active lander or rover mission, the days or sols are referred to by numbers, with sol 001 being the landing day of that particular mission. Local Mars solar times for specific longitudes have been calculated and can be seen at the Mars24 web site. The two MER landing sites (for the rovers named Spirit and Opportunity) are on opposite sides of the planet, so when it is Mars local day at one site, it is Mars local night at the other. The MER science team worked on Mars time rather than Earth time during the first 90 sols of the mission, which meant their day was 24 hours and 37 minutes long, so the beginning of each Mars work day moved to a later time each Earth day.

Captions from the images on following page

Image 1. Bonneville Crater—220 meters in diameter. Small impact craters are simple and bowlshaped with thin and relatively small ejecta blankets. The light pattern on the surface is dust trapped between the rough blocks of the ejecta blanket. The MER rover named Spirit visited Bonneville early in its mission.

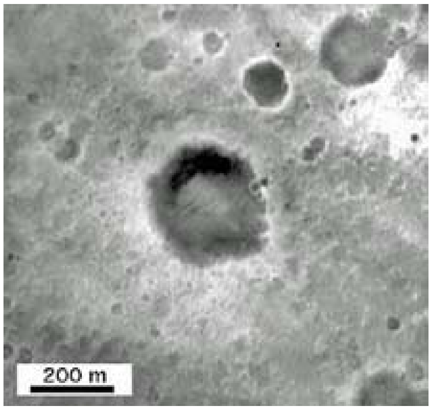
Image 2. Yuty Crater—19 km in diameter. Lobate, mud-puddle-type ejecta blanket.This type of crater is called a Rampart Crater. When craters reach this size they have a central peak within the crater.

Image 3. Arandas Crater—25 km in diameter. Many Martian craters, like this one, show more than one ejecta lobe surrounding the crater. Arandas crater is large enough to have a central peak and is surrounded by a bright halo of material that appears to be clean ice that was excavated from beneath the surface and deposited as ejecta.

Image 4. Target material influences a crater's ejecta blanket and interior structure, as shown in these craters that have formed in an area of thick rock layers. The crater near the center is 37 km in diameter and shows a combination of lobate and radial ejecta.

Image 5. With increasing crater diameter, the ejecta becomes more radial and less lobate. The crater interior also becomes more complicated as crater diameter increases. Crater is 52 km in diameter.

Image 6. Multi-ring Crater. When craters reach approximately 100 km in diameter, the single peak is replaced by a mountainous ring. Peak rings are the intermediate stage in the progression from central peaks to multiple ring basins associated with increasing crater diameter. Crater is 131 km in diameter.



Bonneville Crater—220 meters in diameter

Small impact craters are simple and bowl-shaped with thin and relatively small ejecta blankets. The light pattern on the surface is dust trapped between the rough blocks of the ejecta blanket. The MER rover named Spirit visited Bonneville early in its mission.

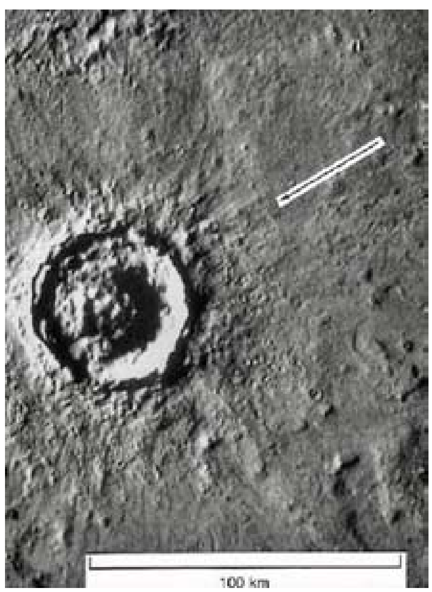
Yuty Crater—19 km in diameter

Lobate, mud-puddle- type ejecta blanket. This type of crater is called a Rampart Crater. When craters reach this size they have a central peak within the crater.

Arandas Crater—25 km in diameter

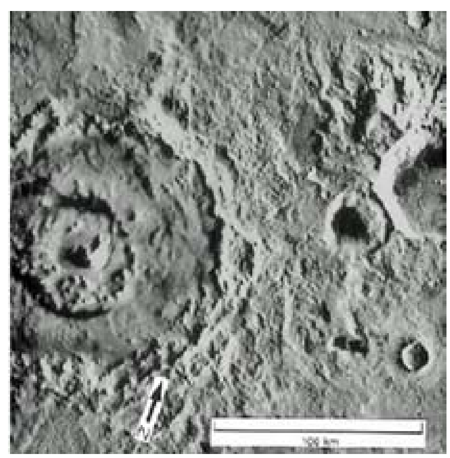
Many Martian craters, like this one, show more than one ejecta lobe surrounding the crater. Arandas crater is large enough to have a central peak and is surrounded by a bright halo of material that appears to be clean ice that was excavated from beneath the surface and deposited as ejecta.

Target material influences a crater's ejecta blanket and interior structure, as shown in these craters that have formed in an area of thick rock layers. The crater near the center is 37 km in diameter and shows a combination of lobate and radial ejecta.



With increasing crater diameter, the ejecta becomes more radial and less lobate. The crater interior also becomes more complicated as crater diameter increases.

Crater is 52 km in diameter.



Multi-ring Crater

When craters reach approximately 100 km in diameter, the single peak is replaced by a mountainous ring. Peak rings are the intermediate stage in the progression from central peaks to multiple ring basins associated with increasing crater diameter.

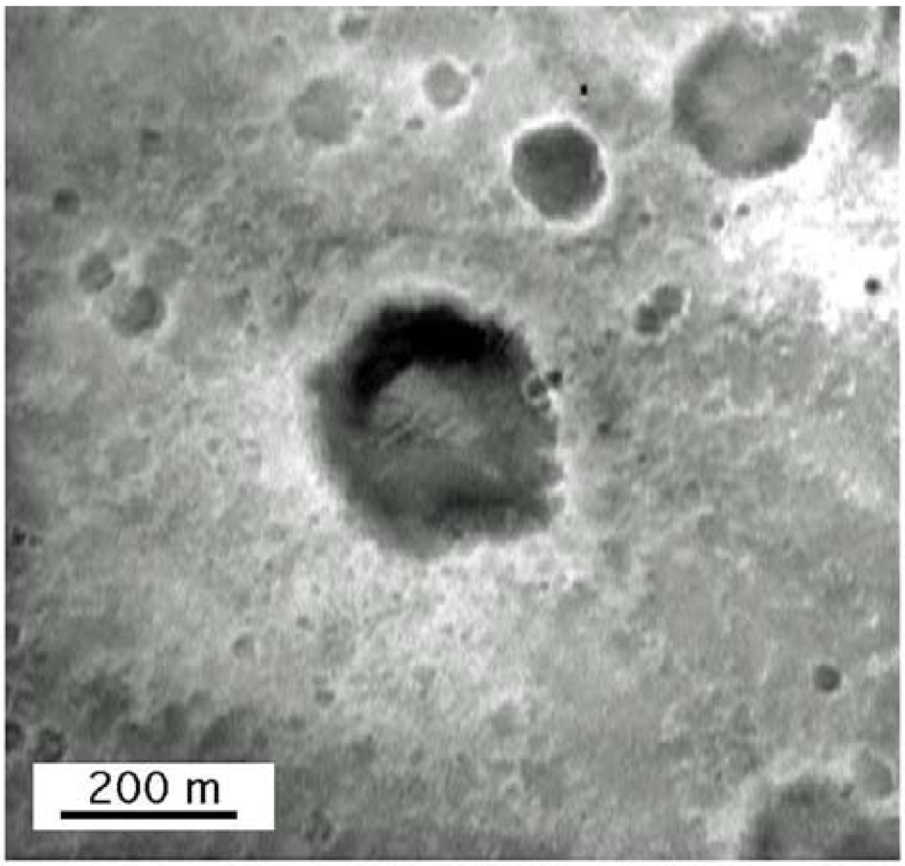
Crater is 131 km in diameter.

220 m

Bonneville Crater, Mars. View from southwest rim. Imaged by MER rover Spirit.

1200 m

Meteor Crater, Arizona, USA. View from southwest rim. Photograph by L.S. Crumpler



Bonneville Crater, Mars. View from descent imaging camera on Spirit Lander.

Crater Features

Below is a list of features produced by an impact event. Enter the letter of each feature in the charts in this booklet to describe what you observe when you make an impact.

A. Crater: a usually circular depression in a surface caused by an impact.
B. Ejecta: material tossed out of a crater by the impact of a projectile.
C. Ejecta blanket: ejecta tossed out of a crater at low speed, lying like a blanket around the crater.
D. Ejecta lines or rays: ejecta tossed out of the crater at high speed which forms long radial lines pointing directly away from the crater.
E. Floor: the interior of the crater that is shaped like a bowl in small craters and flat in large craters.
F. Rim: the raised edge of the crater formed by the outward and upward movement of the crater walls.

Describe any other features you observe:

G. ______________________________

H. ______________________________

I. ______________________________

What is under the craters you made? ______________

____

Mars Exploration Rover Mission Investigation Log

Impact Craters!

Name(s) ______________________________

____

Date ______________________________

Mars Exploration Log: Impact Craters

Try your hand at making some impact craters like those found on the surface of Mars! Choose a box with one of the three types of surfaces. Drop balls (meteorites) of differing sizes and materials onto the surface from differing heights. Then examine what happens to the surface upon impact. Use the letters of features listed on the back page when filling in the charts for each surface. Try all the surface types and note the differences.

Material: Kitty Litter

Material foam glass plastic rubber	Size small medium large	Observations at each height; use letters A–I listed under Crater Features		
		12in	24in	36in

What is Under the Craters?

Impact craters excavate (dig) holes into the surface. Can you describe the material beneath the surface based on the impact craters you made? Write your description on the back of this booklet.

Material: Sand

Material foam glass plastic rubber	Size small medium large	Observations at each height; use letters A–I		
		12in	24in	36in

Material: Sawdust

Material foam glass plastic rubber	Size small medium large	Observations at each height; use letters A–I		
		12in	24in	36in