National Aeronautics and Space Administration

NASA eClips™

Educator Guide

NASA's OUR WORLD

CRATER MAPS AND EARTH LANDFORMS

Educational Product	
Educators & Students	Grades 3-5

EG-2010-09-014-LaRC

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Crater Maps and Earth Landforms

EDUCATOR GUIDE

Grade Level:
3-5

Subjects:
Elementary science and geography

Teacher Preparation Time:
15 minutes

Lesson Duration:
Three 50-minute classes

Time Management:
Class time can be reduced by 50 minutes if students complete the EXPLAIN and EVALUATE at home.

National Standards:

National Science Education Standards (NSES)

Earth and Space Science

- Changes in earth and sky

Science and Technology

- Abilities to distinguish between natural objects and objects made by humans
- Understanding about science and technology

Science in Personal and Social Perspectives

- Types of resources
- Changes in environments

National Council of Teachers of Mathematics (NCTM)

Measurement

- Understand measurable attributes of objects and the units, systems, and processes of measurement

Numbers and Operations

- Compute fluently and make reasonable estimates

US National Geography Standards

- How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective

Essential Questions

- How can the distance between Earth and the moon be demonstrated?
- In what ways are the surface of Earth and the moon alike and how are they different?
- How does technology help us learn about remote places like the moon?

Instructional Objectives:

Students will:

- use a model to visualize the scale and mathematical relationships between the size of the moon and Earth and the distance between the moon and Earth;

- compare Earth's landforms to landforms found on the moon;
- understand that maps are graphic representations of selected physical and human features;
- learn about the NASA Lunar Reconnaissance Orbiter, or LRO, and how NASA learns more about the moon through satellite observations.

Lesson Overview:

This lesson asks students to compare physical features of the moon to those found on Earth. Students first use a tennis ball and basketball to visualize scale relationships and distance between Earth and the moon. Students then use maps of the moon to identify lunar surface geography, comparing lunar landforms to similar ones on Earth. Students learn how NASA uses satellite technology, such as the Lunar Reconnaissance Orbiter, to learn more about the moon. This lesson is developed using a 5E model of learning and utilizes NASA eClips™ video segments.

Icons flag five areas of interest or opportunities for teachers.

- **Technology Icon** highlights opportunities to use technology to enhance the lesson.
- **Modification Icon** denotes opportunities to differentiate the lesson.
- **Resources Icon** relates this lesson to other NASA educator resources that may supplement or extend the lesson.
- **Connections Icon** identifies opportunities to relate the lesson to historical references and other topics or disciplines.
- **Check for Understanding Icon** suggests quick, formative assessment opportunities.

Materials List

ENGAGE

Class demonstration

- basketball (or blow-up globe of Earth similar in size to a basketball)
- tennis ball
- 10-meter length of string
- small model of the space shuttle orbiter (or other small object to represent the shuttle or International Space Station)

EXPLORE

Per pair of students:

- Topographic map
- Map of moon

EXPLAIN

Class demonstration

- shallow baking pan, such as a brownie pan, or a shallow storage bin
- flour
- baking cocoa

EXTEND

Imaginary Moon Map activity

Per group of four students:

- Student Guide
- medium size paper or foam bowls
- straws
- liquid washable tempura paint (black or blue)
- white cardstock
- liquid dishwashing detergent (choose one that makes good bubbles)
- newspapers
- water
- craft sticks for stirring paint mixtures in bowls

NASA Background

On June 18, 2009 the Lunar Reconnaissance Orbiter (LRO) began exploring our nearest neighbor, the moon. Its multi-year mission focuses on mapping the moon's surface to create a comprehensive atlas of the moon's features and resources. The first year of the mission is for planning and then there will be one or more years for data collection and review.

Figure 1.
Lunar Reconnaissance Orbiter
Image credit: NASA

Like Earth, the moon has certain physical features and landforms that have been given special names. The major features of the moon's surface can be seen by just looking up at it. Lighter and darker areas are distinctive terrains. The bright areas are lunar highlands. The darker plains are called lunar maria because, from Earth, they look like seas. Maria is Latin for seas. The circular features so obvious on moon photographs are impact craters formed when meteorites smashed into the surface.

Instruments on LRO are gathering information about the moon's geology and temperature. Other tools are helping scientists build a 3-D topographic map of the moon's landscape. Special cameras are taking images of permanently shaded areas in deep craters, searching for surface water ice.

By recording the number, size and extent of craters lunar geologists can determine the ages of different surfaces on the moon and piece together a geologic history. The comprehensive data provided by LRO will provide even more information about crater slopes and surface roughness, allowing geologists to understand the moon and how it continues to evolve. The data will also help scientists understand more about how Earth was formed and how it might have changed over time.

Resources

Five Things about LRO
http://www.nasa.gov/mission_pages/LRO/news/LROfivethings.html
NASA's LRO Spacecraft Sends First Lunar Images to Earth
http://www.nasa.gov/home/hqnews/2009/jul/HQ_09-152_LROC_images.html
NASA Invites Public to Take Virtual Walk on Moon
http://lunar.gsfc.nasa.gov/
3D Files and Resources
http://www.nasa.gov/multimedia/3d_resources/index.html
3D Full Moon
http://apod.nasa.gov/apod/ap070602.html

5E Inquiry Lesson Development

Before Apollo 11 astronauts Neil A. Armstrong and Edwin E. "Buzz" Aldrin, Jr. stepped on the moon on July 20, 1969; people had studied the moon by eye, telescope and images from spacecraft. As long as people have looked at the moon, they have wondered how far away it is from Earth. The average distance to the moon is 382,500 kilometers (237,675 miles). The distance varies because the moon travels around Earth in an **elliptical orbit**. At perigee, the point at which the moon is closest to Earth, the distance is approximately 360,000 kilometers (223,694 miles). At apogee, the point at which the moon is farthest from Earth, the distance is approximately 405,000 kilometers (251,655 miles).

ENGAGE - (20 minutes)

1. Begin a discussion with students about the Apollo missions to the moon. Use these questions to guide the discussion:
   a. Ask how many people have walked on the moon. (Six successful Apollo

missions landed people on the moon, allowing twelve people to walk on the moon; eighteen were involved in moon missions, but one person remained in the orbiter, circling the moon.)

   b. Ask how many of the astronauts who walked on the moon were women. (No women were included in any Apollo mission. Emphasize for the girls in the group that BOTH men and women are astronauts today.)

   (**CONNECTIONS**) For more information about the participation of women in the space program visit *http://quest.nasa.gov/women/intro.html or http://www.nasa.gov/vision/space/preparingtravel/women_at_nasa.html*

   (**MODIFICATION**) Challenge students to find out about different missions exploring and investigating the moon. They can conduct research to find out the name of the mission, the purpose of the mission, and who was involved in the mission.

2. Explain that although NASA continues to use robotic missions, such as the Lunar Reconnaissance Orbiter, or LRO, and the Lunar Crater Observation and Sensing Satellite, or LCROSS, to learn more about the moon, NASA has not sent people to the moon since 1972.

   (**RESOURCES**) The NASA Educator Guide *Field Trip to the Moon* contains more information about LRO. It can be accessed at *http://www.nasa.gov/pdf/305948main_FTM_LRO_Informal_Guide.pdf*

3. Ask students how far away they think the moon is from Earth. (The average distance to the moon is 382,500 kilometers, or about 237,675 miles.) Ask students how long they think it would take to travel to the moon. (Rockets using current propulsion systems take between 2.5 and 4 days to arrive at the moon.)

4. Use this simple model to illustrate the unique mathematical relationship between Earth and the moon.

   a. Ask one student to hold the basketball and stand in the corner of the room to represent Earth. Ask a second student to hold the tennis ball to represent the moon. These two balls have a scale relationship similar to that of Earth and moon. The moon has a diameter one-fourth the size of Earth's diameter.

   b. Ask the student holding the moon to estimate where to stand to represent how far away the moon is from Earth. Encourage the other students to help the student decide where to stand.

   c. Once the students are in place, share these facts to help adjust and verify the distance between the moon and Earth in the model.

      - The circumference of Earth (distance around Earth at the equator) is approximately 40,000 kilometers (25,000 mile).

- The distance to the moon is 10 times the circumference of Earth, or approximately 400,000 kilometers (250,000 miles).

d. Ask students to discuss how they might check to see if the person holding the softball/moon is the correct distance from the basketball/Earth. (Students should suggest using the fact that the distance to the moon is 10 times the circumference of Earth to check the model.)

e. Suggest wrapping a string around the basketball ten times to measure the scale distance between the moon and Earth. Students may also suggest wrapping string once around the ball and multiplying this distance 10 times to equal the scale distance between the moon and Earth.

f. Ask one student to hold the string at Earth and another student to stretch the string to represent the distance from Earth to the moon. The end of the string is where the moon should be.

g. Compare how close the students' estimates were to the actual measurement.

h. Ask students where they think the space shuttle's orbit would fit in this model. (Most students guess about half-way to the moon. Explain that the shuttle actually flies in low-Earth orbit, which is again a mathematical relationship in this scale model. Low-Earth orbit is only about 350 kilometers (250 miles) above the surface of Earth. On our scale model, the shuttle should be approximately one centimeter from the basketball.)

5. (**TECHNOLOGY**) To explain more about low-Earth orbit and the distance between the moon, Earth, and International Space Station, watch the NASA eClips™ video segment "*Our World: On Board The International Space Station*" (5:57)
   http://www.nasa.gov/audience/foreducators/nasaeclips/search.html?terms="on-board%20the%20international%20space%20station"&category=1000
   (**MODIFICATION**) This video may also be streamed in high definition from the NASA eClips You Tube™ channel:
   http://www.youtube.com/user/NASAeClips#p/c/31002AD70975DC1B/8/V8c-DctLxLo

EXPLORE - (50 minutes)

On Earth, specific landforms are given geographic names. Students may be familiar with mountains, canyons, deltas, plains, lakes, oceans, and rivers. A relief, or topographic, map uses colors or shades to indicate different elevations. A physical map shows the natural physical features, such as mountains and rivers. A political map is used to show cultural features, like the boundaries of countries or states. A coordinate system using latitude and longitude is used to identify specific locations on Earth.

1. Have the class complete a KHWL chart to organize what your students KNOW, HOW they know this information, and what they WANT TO KNOW about the moon and its landforms. Student will return to this chart throughout the lesson to add what they have LEARNED about the moon. Use these questions to help guide the discussion:
   - What do you KNOW about the moon and its features? (Answers will vary. Students may suggest ideas that are incorrect. Do not correct these ideas at this time. You will come back to this KHWL chart throughout the lesson to correct any misconceptions and add more facts. For example, students may think that lunar regolith is the same as Earth soil.
   - Ask students to explain HOW they have learned the information stated about the moon. (Answers will vary. This is the time to help students consider the validity of their sources for information.)
   - What do you WANT TO KNOW about the moon? (Answers will vary. Encourage students to seek answers to their questions beyond this lesson.)
2. Show an example of a topographic map of Earth to the class. Use this map to begin a discussion about Earth's landforms. Ask students to name common landforms on Earth and discuss how these landforms are depicted on the map. (The landforms typically visible on global topographic map are continents, mountain chains, river valleys, oceans basins.)
   (**TECHNOLOGY**) Satellite images of Earth's topography can be found at *http://education.usgs.gov/common/primary.htm#satellite or http://earthshots.usgs.gov/tableofcontents.*
3. Have students look at a map of the moon. Ask students how they think landforms on Earth compare with landforms on the moon. Discuss why there may or may not be differences between the two types of landforms.
   (**TECHNOLOGY**) Students can look at maps of the moon at the following web sites:
   Google Moon web site: *http://www.google.com/moon/*
   Consolidated Lunar Atlas: *http://www.lpi.usra.edu/resources/cla/*

EXPLAIN – (20 minutes)

Like Earth, the moon has certain physical features that have been given special names. The lighter areas on the moon are bright lunar highlands. Careful observations show that the highlands are scarred by millions of round craters caused by the high speed collision of asteroids, comets, and meteorites with the moon.

EDUCATOR GUIDE

The impact process is explosive. When the object hits the moon's surface, it is traveling very fast. A huge high-pressure wave is formed upon impact. Some of the material on the surface is melted upon impact, but the majority of the material is strongly fractured and tossed out of the target area, piling up around the hole that is made. The bottom of the crater is lower than the original ground surface and the material piled up on the rim is higher. This material that was thrown from the hole is called crater ejecta. Sometimes a small amount of the material is blasted a great distance away along unique lines. These bright streaks of material are known as rays.

Because there is no erosion caused by wind or precipitation on the moon, the craters and the ejecta change very slowly compared to landforms on Earth. These craters range in size; the largest craters are up to 1000 kilometers in diameter.

The moon does not have many volcanic craters, like those found on Earth, but it did experience volcanic activity. Lava flowed from lunar fractures, or crustal cracks, to fill low areas, forming flat plains of basalt, the same type of volcanic rock found on Earth. These plains, or maria, appear as large dark areas on the moon. About 16% of the lunar surface is covered by maria. Early astronomers thought these dark areas were bodies of water and used the Latin word mare, meaning sea, to name them. Although we know now that the moon never had any large bodies of water, we still use the name. The maria are concentrated on the side of the moon that faces Earth. The far side has very few of these plains. Scientists do not agree on the explanation for this distribution of maria on the moon.

A rille is a channel in the lunar maria. These rilles were open lava channels or collapsed lava tubes that carried the lava that made the maria.

The surface of the moon is covered with a thin blanket of lunar material called regolith. This material has none of the organic matter found in soils on Earth. Instead it consists of pulverized pieces of rocks and glassy fragments formed by the impacts. The chemical composition of the regolith reflects the composition of the rocks underneath.

1. Demonstrate how impactors affect the surface of the moon.
    a. Cover the bottom of a shallow, flat pan such as a brownie pan or storage bin with a layer of flour about 1 cm thick.
    b. Sprinkle baking cocoa over the flour so the top layer is brown.

c. Drop several rocks of different sizes into the pan and have students observe the results. To illustrate how the angle and speed of an impactor affects crater formation, drop the rocks from different heights and throw them into the mixture at different angles.

d. If there is time, have students measure the mass of the rock and the size of the craters and rays formed by the rocks.

(**TECHNOLOGY**) Use a document camera and projector to allow students to see the demonstration.

2. Ask students to label the features of the moon's surface in figures 8 and 9 on page 6 of the Student Guide.
3. (**MODIFICATION**) Show students the pictures of craters on Earth featured in this NASA article
http://nasadaacs.eos.nasa.gov/articles/2005/2005_craters.html.
Ask students to compare these Earth craters to pictures of moon craters. They should notice that weathering and erosion are affecting the Earth craters. Note that the first and last photos are of volcanic craters.
4. (**RESOURCES**) The NASA Educator Guide Exploring the Moon has more information on moon landforms as well as other background information about the moon. This guide can be accessed at
http://www.nasa.gov/pdf/58199main_Exploring.The.Moon.pdf.

EXTEND – (35 minutes)

1. Ask students to discuss how scientists know about the moon's landforms. Discuss how technology helps scientists learn about remote places like the moon.
2. Tell students that the LRO mission is an effort among several NASA teams of researchers to find out more about the moon. The LRO contains several instruments designed to collect data. Ask students to answer the following questions:
    a. What information do you think we need to know about the moon? (*Answers will vary but may include the presence of water, the presence of life, or what kinds of dangers exist for humans.*)
    b. How would you collect this data? (*Answers will vary but may include a spacecraft could orbit the moon or a spacecraft could land on the surface of the moon.*)
3. (**TECHNOLOGY**) Show students the NASA eClips™ video segments, "*Our World: The Lunar Reconnaissance Orbiter*" (4:56) and *Our World:*

Instruments on the Lunar Reconnaissance Orbiter" (4:44). These videos or a captioned version may be streamed or downloaded from the NASA eClips™ page of the NASA web site: *http://www.nasa.gov/audience/foreducators/nasaeclips/search.html?terms="The%20lunar%20reconnaissance%20orbiter"&category=1000*

(**MODIFICATION**) These videos may also be streamed in high definition from the NASA eClips You Tube™ channel:

"*Our World: The Lunar Reconnaissance Orbiter*" *http://www.youtube.com/nasaeclips#p/c/31002AD70975DC1B/44/dlM5aUPs5H8*

"Our World: Instruments on the Lunar Reconnaissance Orbiter"

http://www.youtube.com/nasaeclips#p/c/31002AD70975DC1B/43/oSRc8Yk2nzE

4. After watching the video, have students conduct additional research to answer some or all of the following questions:
   a. What are the instruments on the LRO? (*DLRE: Diviner Lunar Radiometric Experiment, LEND: Lunar Exploration Neutron Detector, Mini-RF Technology Demonstration, CRaTER: Cosmic Ray Telescope for the Effects of Radiation, LAMP: Lyman Alpha Mapping Project, LOLA: Lunar Orbiter Laser Altimeter, LROC: Lunar Reconnaissance Orbiter Camera.*)
   b. What is the purpose of each instrument? (*The DLRE is charting the temperatures of the entire lunar surface. The LEND is measuring space radiation and hydrogen content. The Mini-RF Technology Demonstration is searching for water ice below the lunar surface. The CRaTER is testing the effects of cosmic rays on models of living tissue (tissue- equivalent plastics.*) *The LAMP is mapping the entire lunar surface in ultraviolet to search for water ice in the north and south poles. The LOLA is measuring the topography of the lunar surface and looking for ice at the lunar poles. The LROC is taking detailed images of the lunar surface to find the best landing sites.*)
   c. What are some of the jobs of the people working on the LRO mission? (*Answers should include space scientists, geologists, engineers, mathematicians, and computer scientists. These scientists and engineers plan the missions; design and build the instruments; and study, graph, and share the collected data.*)

   (**RESOURCES**) Students can find out more about these professions at *http://kids.earth.nasa.gov/archive/career/index.html*

5. (**CHECK FOR UNDERSTANDING**) Other possible questions to ask students after viewing the video include:
   a. What are some of the engineering challenges of exploring the moon? (*Answers will vary but may include ideas such as: the distance to the*

moon makes it hard to collect data and to repair instruments that are damaged during travel; the harsh environment makes human exploration difficult.)

b. How do these challenges compare to exploring Earth? (*Answers will vary, but may include ideas such as: more than 70% of Earth is covered with water; we do not have the technology to look deep below the ocean*.)

c. How can scientists learn more about Earth by studying the moon? (*The moon is made up of the same materials found on Earth, but these materials have never been exposed to the weathering processes found on Earth. By learning more about the moon, NASA scientists hope to learn more about how Earth was formed and how it might change over time*.)

EVALUATE (30 minutes)

1. Have students fill in what they have learned in their KHWL chart.

   The following evaluations can be done individually, in small groups, or as a class:

2. Ask students to compare common landforms on Earth to geographic features on the moon. Discuss how the landforms are similar and how they are different.

3. (**TECHNOLOGY**) Students may create a digital video collage or slide presentation comparing Earth and moon landforms.

Art Extension - Create an imaginary moon map

Follow these directions to help small groups of students create bubble pictures of the surface of an IMAGINARY moon.

a. Stations may be set up to allow a small number of students at a time to make their pictures. Bubble and paint mixture should be stirred immediately before blowing bubbles.

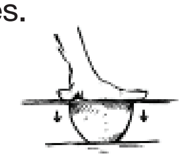
b. Cover table with newspaper or place newspaper underneath each bowl.

c. Mix approximately 45 mL (3 Tablespoons) of liquid dishwashing detergent, 90 mL (6 Tablespoons) of tempera paint, and 120 mL (1/2 cup) of water into each bowl. Stir mixture thoroughly with a craft stick.

d. Give each student a clean straw. Ask students to use the straw and GENTLY blow bubbles in the bowl. The bubbles should form a mound above the rim of the bowl. (Note: If mixture does not form dark colored bubbles or does not make good bubbles, add additional paint or dishwashing liquid.)

e. Be sure that students understand to blow into the straw rather than suck on the straw.
   (**MODIFICATION**) If students are not developmentally able to blow the bubbles, the teacher may blow the bubbles and ask the students to help place the paper over the bowl.

f. Ask students to carefully remove the straw from the bowl. Take the cardstock and lay it carefully on top of the mass of bubbles. Push lightly on the paper tracing the rim of the bowl with fingers to give the picture a distinct edge. The pressure of the paper will pop the bubbles and produce crater-like surface.



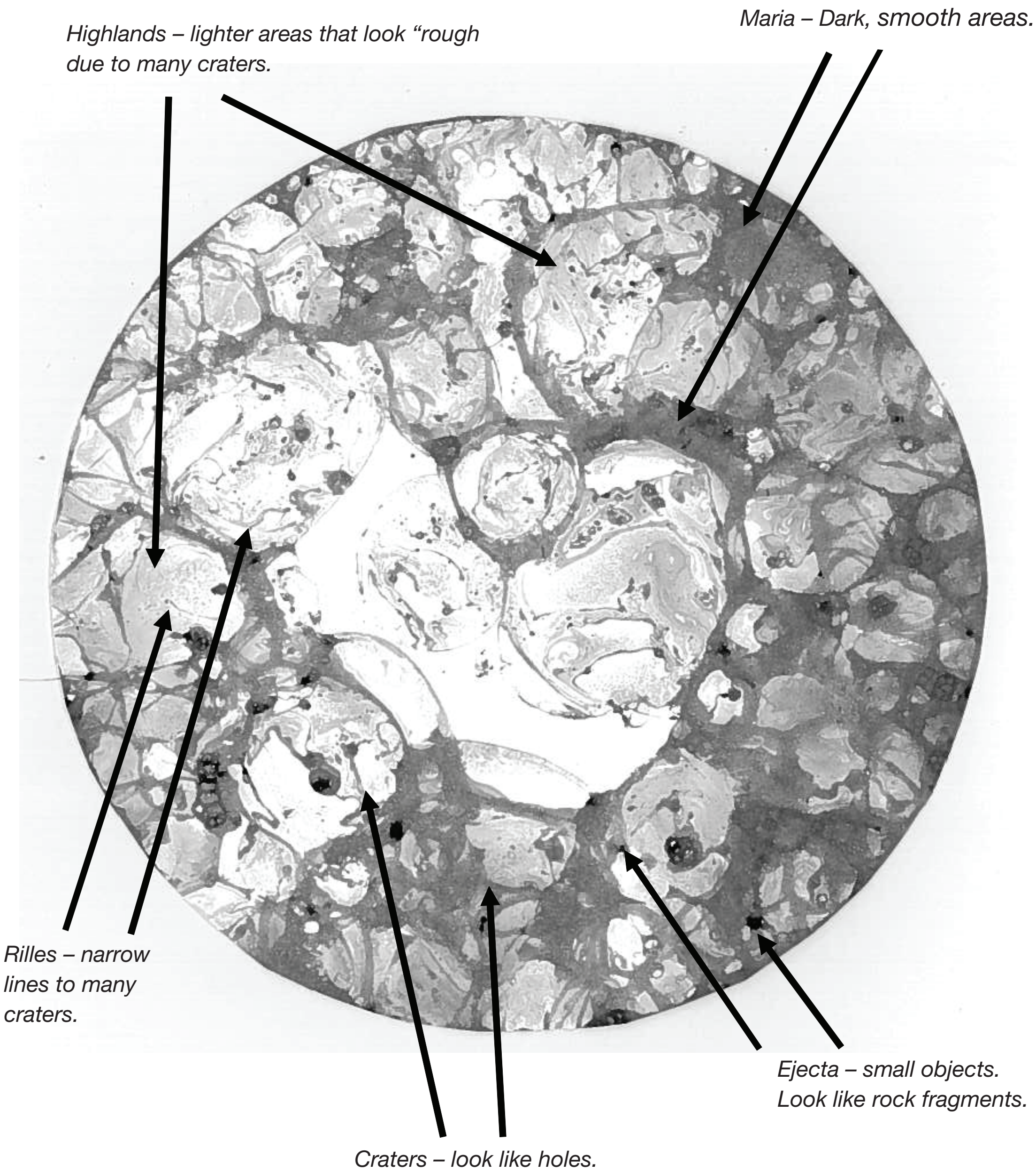
g. Leave the paper on top of the bowl for 30 seconds before removing it. Be sure students put their names on their papers because the pictures will be similar.

h. Lay the pictures flat to allow the paint to dry. Pictures are dry to touch in just a few minutes.

i. Before creating the next picture, gently wipe the rim of the bowl with a clean paper towel to remove any excess or splashed paint mixture.

7. (**CHECK FOR UNDERSTANDING**) Ask students to label the features on their imaginary moon maps using the pictures in the Student Guide as examples.
8. (**CONNECTIONS**) After teaching students the official names of “Terra” for Earth and “Luna” for Earth’s moon, connect the expression “Terra firma” spoken by sailors and other travelers, and the term “terrestrial” to our home planet’s name of Terra. Older students can also connect terms such as lunacy and lunatic to “Luna,” further expanding their knowledge.

Sample Imaginary Moon Map



NASA eClips™

Crater Maps and Earth Landforms

nasa's our world

STUDENT GUIDE

Landforms on Earth

Landforms are one of Earth's physical features. Physical features are nonliving. Earth's physical features are always changing.

Erosion and weathering are two forces that change Earth's landforms. Erosion happens when wind, water, and glaciers slowly carry away the land. Weathering is what happens when rocks are broken down into smaller pieces by wind, rain, snow, water, tree roots, and changes in temperature.

Some of the landforms on Earth and types of maps used to show Earth are listed here:

coordinate system – A coordinate system is a grid placed on a map to help quickly locate specific locations.

highlands – Highlands are mountainous regions of land.

hill – A hill is raised above the surrounding land, but is smaller than a mountain.

lowlands – The lowlands are sections of ground lower than the surrounding area. A valley is an example of lowlands.

Luna – Luna is the official name of Earth's moon.

mountain – A mountain is any place on Earth that rises sharply and is well above its surroundings.

physical map – A physical map shows the location of major landforms such as mountains, plains, and deserts. It also shows country borders and major cities.

plains – Plains are large, flat, level ground. Plains are often covered with low grasses and have very few or no trees.

political map – A political map shows the location of cities and the borders of countries and states.

relief map - A relief map shows the variation in land heights. The different heights are shown as lines or different colors.

Terra – Terra is the official name of Earth.

valley – A valley is a place that is naturally lower than the surrounding land. Valleys are often located between mountains or hills.

Landforms on the Moon

Large landforms on the moon can be seen from Earth. Binoculars and telescopes help us see some details of the moon's surface.

To see more details on the moon's surface, NASA sends spacecraft to the moon.

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The **Lunar Reconnaissance Orbiter**, or **LRO**, is orbiting the moon. As it orbits, LRO sends back black-and-white and color images and temperature readings of the moon's surface.

Craters cover the surface of the moon. Craters form when an object hits the moon's surface. When this happens, the moon's material is broken up and thrown out of the crater and piles up around the hole that is made. Some of the material is thrown far from the crater. This material is called **ejecta.**

Sometimes lines or streaks are created from the materials that are thrown from the crater. Theses streaks of material are called **rays.**

Because there is no weather or erosion caused by wind or rain on the moon, the craters and their ejecta only change slowly. These craters range in size from ones too small to see to giant basins a thousand kilometers across.

Use these descriptions and images to identify lunar landforms on a map.

crater – A crater is a hole caused by an object hitting the surface of a planet or moon. Craters are sometimes called impact craters to describe the force that is used to create the hole.

Craters form when an object hits the moon's surface at very high speed. When this happens, lunar rocks are smashed to pieces and thrown out of the crater, piling up around the hole that is made. Some of the material is thrown far from the crater. This material is called ejecta.

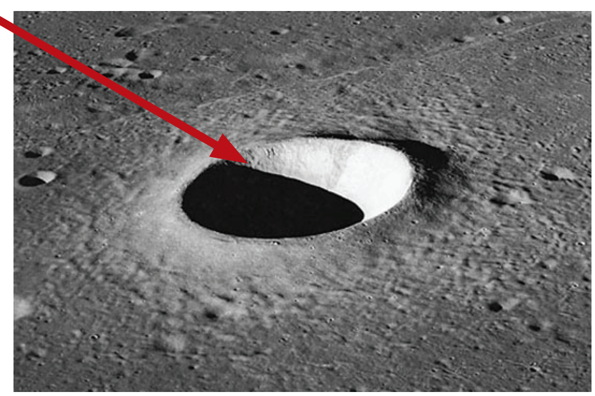

Figure 1: Crater.
Image: NASA

ejecta – Ejecta is material that is thrown out of a crater when the crater is formed. When craters form, the surface of the moon is broken into rocks and dirt. The ejecta may be thrown far from the crater.

Because there is no weather or erosion caused by wind or rain on the moon, the craters and the ejecta remain unchanged for a very long time. These craters range in size; the largest craters are up to 1000 kilometers in diameter.

Figure 2: Ejecta
Image: NASA

highlands – Highlands on the moon look like lighter patches of land from Earth. These patches have many craters.

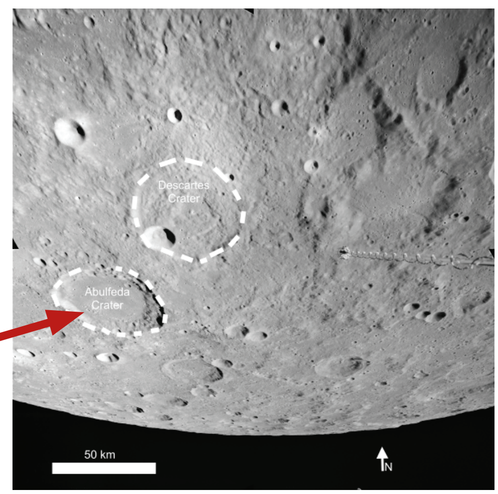

Figure 3: Highlands
Image: NASA

STUDENT GUIDE

maria – Maria on the moon look like dark areas from Earth. A close look at maria shows that these areas are smoother than the highlands. Maria are dark volcanic rock called **basalt**. The word maria is the Latin word for seas. When people first looked at the moon through telescopes, they thought the dark areas were water and called them seas, or maria. A single maria is called a mare.

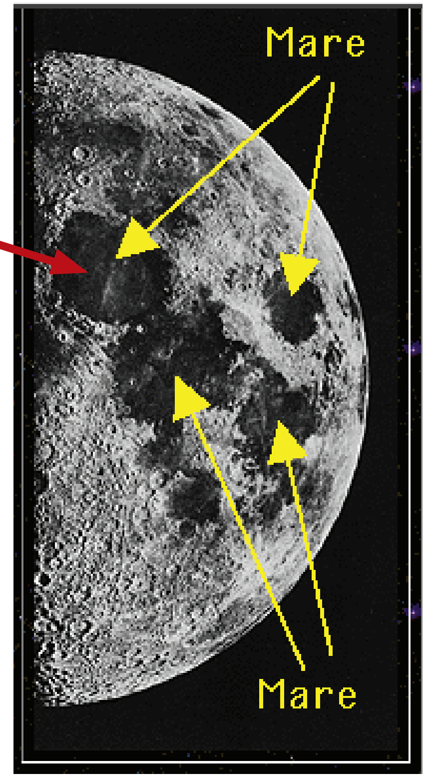

Figure 4: Maria
Image: NASA

ray – A ray looks like a white line or streak extending from a crater. It is a bright streak of material that was thrown out of the crater after something hit the moon's surface. In other words, rays formed from materials that were originally where the crater is now.

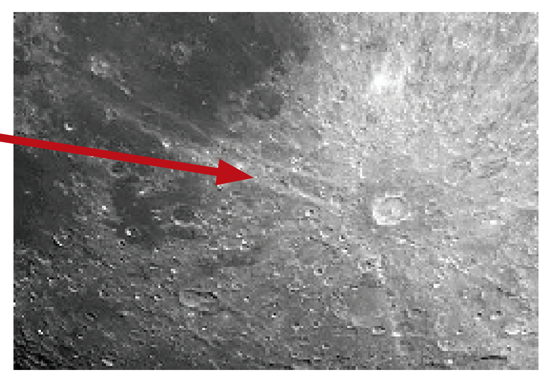

Figure 5: Ray
Image: NASA

rille – A rille is a narrow tube, or channel, in the maria. This channel once carried lava.

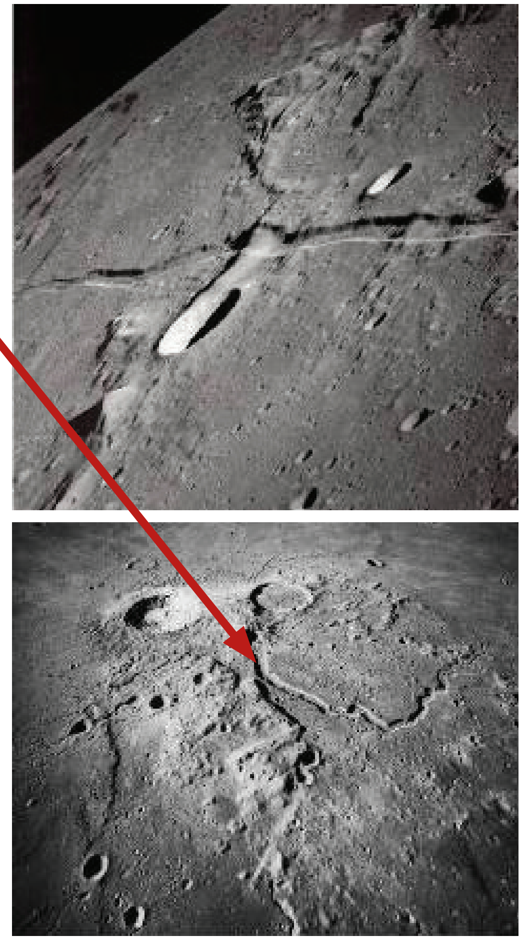

Figure 6 & 7: Rille
Image: NASA

NASA has taken many pictures of the moon's surface. What landforms can you identify?

Figure 8:
Apollo 15
image.
Image: NASA

Figure 9:
Moon-North Polar
Mosaic picture
Image: NASA