A‘a: Blocky, angular, and rough type of lava flow.
Agglutinates: Common particle type in lunar sediment; agglutinates consist of small rock, mineral, and glass fragments bonded together with glass.
Agronomist: Scientist who studies soil management and the production of field crops.
Anomaly: A deviation from the common rule, type, or form; something abnormal or inconsistent.
Anorthosite: An igneous rock made up almost entirely of plagioclase feldspar.
Antenna: A conductor by which electromagnetic waves are transmitted or received.
Apollo: U.S. Space Program which included 6 piloted lunar landings between 1969 and 1972. Apollo astronauts collected and returned 382 kilograms of rock and sediment samples from the Moon.
Astronaut: Person engaged in or trained for spaceflight.
Atmosphere: Mixture of gases that surround a planet.
Basalt: Fine-grained, dark-colored igneous rock composed primarily of plagioclase feldspar and pyroxene; other minerals such as olivine and ilmenite are usually present.
Beneficial: Advantageous, helpful.
Biodegradable (see Nondegradable): Capable of decaying and being absorbed by the environment.
Biosphere: The part of Earth's crust, water, and atmosphere where living organisms can survive.
Botanist: Scientist who studies plant life.
Breccia: Rock consisting of angular, coarse fragments embedded in a fine-grained matrix.
Celsius: A temperature scale that assigns the value 0°C to the freezing point of water and the value of 100°C to the boiling point of water at standard pressure.
Channel: A furrow or narrow passageway in the ground.
Clementine: A global mapping mission to the Moon launched in 1994 by the U.S. Department of Defense, with science support from NASA.
Communications: A means of transmitting and receiving information.
Console: A desklike structure that is the control unit of an electrical or electronic system.
Consumption: The act of eating or drinking; using energy and materials.
Core: The central region of a planet or moon frequently made of different materials than the surrounding regions (mantle and crust). Earth and the Moon are thought to have cores of iron and nickel.
Crater (see Impact): A hole or depression. Most are roughly circular or oval in outline. On Earth most natural craters are of volcanic origin. On the Moon most are of impact origin.
Crater chain: Several craters along a general line.
Crust: The outermost layer of a planet or moon, above the mantle.
Dark mantle deposits: Deposits of dark glass on the Moon, possibly products of volcanic fire fountaining.
Density: Mass per volume; how much material in a given space.
Descartes: Lunar highlands site of Apollo 16 landing on April 21, 1972.
Development: The act of bringing into being or advancing to a more effective state.
Differentiation: Chemical zonation caused by differences in the densities of minerals; heavy materials sink, less dense materials float.
Drought: Extended period of dry weather, especially one causing damage to crops.
Earthquake: Sudden motion or trembling of Earth caused by the abrupt release of slowly accumulated elastic energy in rocks.
Ejecta: Material thrown out from and deposited around an impact crater.
<table>
<thead>
<tr>
<th><strong>Electricity:</strong></th>
<th>Energy caused by the motion of electrons, protons, and other charged particles.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Entertainment:</strong></td>
<td>Amusement, or diversion; something to hold attention for pleasure.</td>
</tr>
<tr>
<td><strong>Erosion:</strong></td>
<td>Removal of weathered rocks by moving water, wind, ice, or gravity.</td>
</tr>
<tr>
<td><strong>Eruption</strong> (see Source):</td>
<td>A break out or brust of volcanic matter.</td>
</tr>
<tr>
<td><strong>Fahrenheit:</strong></td>
<td>A temperature scale with the freezing point of water assigned the value 32°F and the boiling point of water 212°F.</td>
</tr>
<tr>
<td><strong>Farside:</strong></td>
<td>The side of the Moon that never faces Earth.</td>
</tr>
<tr>
<td><strong>Feasible:</strong></td>
<td>Capable of being done or accomplished; probable, likely.</td>
</tr>
<tr>
<td><strong>Fissure:</strong></td>
<td>Crack extending far into a planet or moon through which magma travels to and erupts onto the surface.</td>
</tr>
<tr>
<td><strong>Food groups:</strong></td>
<td>Categories into which all foods are divided; meats and protein, fruits, vegetables, dairy, carbohydrates, and sugars.</td>
</tr>
<tr>
<td><strong>Fra Mauro:</strong></td>
<td>Landing site of Apollo 14 on the Moon on February 5, 1971.</td>
</tr>
<tr>
<td><strong>Geologist:</strong></td>
<td>Scientist who studies Earth, its materials, the physical and chemical changes that occur on the surface and in the interior, and the history of the planet and its life forms. Planetary geologists extend their studies to the Moon, planets, and other solid bodies in the Solar System.</td>
</tr>
<tr>
<td><strong>Giant impact theory:</strong></td>
<td>An explanation for the origin of the Moon from Earth debris which collected in space after a projectile the size of planet Mars smashed into a growing Earth.</td>
</tr>
<tr>
<td><strong>Hadley-Appenine:</strong></td>
<td>Landing site of Apollo 15 on the Moon on July 31, 1971.</td>
</tr>
<tr>
<td><strong>Highland &quot;soil&quot;:</strong></td>
<td>Sediment on the surface of the lunar highlands; composed of broken rock and mineral fragments, and glass produced by impact.</td>
</tr>
<tr>
<td><strong>Highlands:</strong></td>
<td>Oldest exposed areas on the surface of the Moon; extensively cratered, and chemically distinct from the maria.</td>
</tr>
<tr>
<td><strong>Igneous:</strong></td>
<td>Rocks or processes involving the formation and solidification of hot, molten magma.</td>
</tr>
<tr>
<td><strong>Ilmenite:</strong></td>
<td>Opaque mineral found in basalt; nearly pure iron-titanium oxide (FeTiO₃)</td>
</tr>
<tr>
<td><strong>Impact</strong> (see Crater):</td>
<td>The forceful striking of one body, such as an meteorite, against another body such as a moon or planet.</td>
</tr>
<tr>
<td><strong>Impactor</strong> (see Projectile, Meteorite):</td>
<td>Object that impacts a surface.</td>
</tr>
<tr>
<td><strong>KREEP:</strong></td>
<td>On the Moon, type of highlands rock rich in potassium (K), rare-earth elements (REE), and phosphorus (P).</td>
</tr>
<tr>
<td><strong>Latitude:</strong></td>
<td>The angular distance North or South from the Earth's equator measured in degrees on the meridian of a point; Equator being 0° and the poles 90°N and 90°S.</td>
</tr>
<tr>
<td><strong>Lava:</strong></td>
<td>fluid magma that flows onto the surface of a planet or moon; erupted from a volcano or fissure. Also, the rock formed by solidification of this material.</td>
</tr>
<tr>
<td><strong>Levees:</strong></td>
<td>Zones in a lava flow where the lava between the zones is moving faster than the lava outside the zones.</td>
</tr>
<tr>
<td><strong>Lifestyle</strong> (see Sedentary):</td>
<td>A person's general pattern of living.</td>
</tr>
<tr>
<td><strong>Longitude:</strong></td>
<td>The angular distance East or West, between the meridian of a particular place on Earth and that of Greenwich, England, expressed in degrees or time.</td>
</tr>
<tr>
<td><strong>Lunar:</strong></td>
<td>Of or pertaining to the Moon.</td>
</tr>
<tr>
<td><strong>Lunar Prospector:</strong></td>
<td>U. S. Discovery-class mission to the Moon scheduled for launch in early 1998. Its instruments are designed to provide global maps and data sets of the Moon's composition and magnetic and gravity fields from a low polar orbit.</td>
</tr>
<tr>
<td><strong>Magma:</strong></td>
<td>Term applied to molten rock in the interior of a planet or moon. When it reaches the surface, magma is called lava.</td>
</tr>
<tr>
<td><strong>Magma Ocean:</strong></td>
<td>Term used to describe the layer of magma, hundreds of kilometers thick; thought to have covered the Moon 4.5 billion years ago.</td>
</tr>
<tr>
<td><strong>Magnetic field:</strong></td>
<td>The region of &quot;altered space&quot; that will interact with the magnetic properties of a magnet. It is located mainly between the opposite poles of a magnet or in the energetic...</td>
</tr>
</tbody>
</table>
space about an electric charge in motion.

**Mantle:** A mostly solid layer of Earth lying beneath the crust and above the core, consisting mostly of iron, magnesium, silicon, and oxygen.

**Mare basalt:** Rocks making up the dark, smooth, mare areas of the Moon.

**Mare "soil":** Sediment on the surface of the lunar maria; fragments of basalt rocks, broken mineral grains, and glass produced by impact.

**Maria (mare):** Dark areas on the Moon covered by basalt lava flows.

**Metamorphic:** Rocks that have recrystallized in a solid state as a result of changes in temperature, pressure, and chemical environment.

**Meteorite (see Impactor, Projectile):** A metallic or stony (silicate) body that has fallen on Earth or the Moon from outer space.

**Meteoritic bombardment:** Intensive and prolonged impacts of a surface by meteorites or other impactors.

**Mineral:** Naturally occurring inorganic solid with a definite chemical composition and crystal structure.

**Moonquake (see Earthquake):** Sudden motion or trembling of the Moon caused by the abrupt release of slowly accumulated elastic energy in rocks.

**Mountain:** A natural elevation of a planetary surface.

**NASA:** United States federal agency; National Aeronautics and Space Administration.

**Nearside:** The side of the Moon that always faces Earth.

**Nondegradable (see Biodegradable):** Something that can not be chemically decomposed.

**Norite:** Igneous rock found in the lunar highlands composed of plagioclase and pyroxene.

**Nuclear energy:** Process by which the fission of $^{235}\text{U}$ releases heat to make steam, which then drives turbines to create electricity.

**Nutrition:** Process by which animals and plants take in and utilize food material.

**Ocean of Storms:** Landing site of Apollo 12 on the Moon on Nov. 19, 1969; Oceanus Procellarum.

**Olivine:** Mineral found in basalt; ranges from $\text{Mg}_2\text{SiO}_4$ to $\text{Fe}_2\text{SiO}_4$.

**Orange "soil":** On the Moon, a mixture of very small dark orange and black glass balls which formed from quickly cooled lava droplets during a pyroclastic eruption.

**Organism:** Any form of animal or plant life.

**Pahoehoe:** Basaltic lava with a smooth, billowy, orropy surface.

**Photosynthesis:** The process by which plants convert water and carbon dioxide into carbohydrates, using sunlight as the source of energy and the aid of chlorophyll.

**Plagioclase feldspar:** Common mineral; ranges from $\text{NaAlSi}_3\text{O}_8$ to $\text{CaAl}_2\text{Si}_2\text{O}_8$.

**Plate tectonics:** Theory formulated in the late 1960s that states the Earth's crust and upper mantle (a layer called the lithosphere) is broken into moving pieces called plates. The formation of mountains and volcanoes, and the occurrence of earthquakes have been explained using this theory.

**Pressure ridges:** Long, narrow wavelike folds in the surface of lava flows; formed where lava may have buckled up against slower moving or stationary lava downstream.

**Projectile (see Impactor, Meteorite):** Object that impacts a surface.

**Pyroclastic eruption:** Explosive eruption of lava producing and ejecting hot fragments of rock and lava.

**Ray:** Streak of material blasted out and away from an impact crater.

**Recycling:** To treat or process waste materials making them suitable for reuse.

**Regolith (see Sediment, Soil):** Loose, unconsolidated rock, mineral, and glass fragments. On the Moon, this debris is produced by impacts and blankets the surface.

**Rille:** Long channel on the Moon crossing the surface of maria; probably formed either as an open channel in a lava flow, or as an underground tube carrying hot lava which collapsed as the lava flowed out.
Robot: A machine that does mechanical tasks on command and operates automatically.

Rock: A naturally formed solid that is an aggregate of one or more minerals.

Scale: The relationship of a distance on a map or model to the true distance in space; written as a ratio, such as 1:24,000.

Sea of Serenity: One of the maria on the Moon's nearside; Mare Serenitatis.

Sea of Tranquillity: Landing site of Apollo 11 on the Moon on July 20, 1969; Mare Tranquillitatis.

Sedentary (see Lifestyle): characterized by much sitting and little physical activity.

Sediment (see Regolith): Sediment rock or mineral fragments transported and deposited by wind, water, gravity, or ice; precipitated by chemical reactions; or secreted by organisms; accumulated as layers in loose, unconsolidated form.

Sedimentary: Rock formed when sediment is compacted and lithified.

Self-sustaining: Able to exist and function without outside help.

SNC meteorites (see Meteorite): Group of meteorites with relatively young ages (slightly over 1 billion years old) that probably came from Mars.

Soil (see Regolith, Sediment): The upper layers of sediment on Earth that support plant growth.

Solar power: Energy derived from the Sun or sunlight for use as a source of electricity.

Solar system: The Sun and all the objects (planets, moons, asteroids, and comets) that orbit the Sun.

Solar wind: The stream of charged particles (mainly ionized hydrogen) moving outward from the Sun with velocities in the range 300-500 kilometers per second.

Source (see Eruption): Location where igneous matter (lava and gases) erupts onto the surface; vent, fissure, volcano, etc.

Spacecraft: Vehicle capable of traveling in outer space.

Stratigraphy: Study of layered rock to understand the sequence of geological events.


Terrain: Area of the surface with a distinctive geological character.

Tool carrier: Storage container for tools on the Apollo Lunar Roving Vehicle.

Transportation: The means of carrying something from one place to another.

Troctolite: Igneous rock found in the lunar highlands composed of plagioclase and olivine.

Vesicle: Bubble-shaped cavity in a volcanic rock formed by expanding gases.

Volatile: Chemical elements that enter a vapor phase at relatively low temperatures.

Volcano: Mountain formed from the eruption of igneous matter through a source vent.

Water conservation: The wise use of water as a natural resource; the prevention of loss or waste of water.

Weathering: The mechanical breakdown and chemical alteration of rocks and minerals at Earth's surface during exposure to air, moisture, and organic matter.

Zoologist: Scientist who studies animals.
World Wide Web Resources for Educators for the Moon

**Lunar Exploration**

http://cass.jsc.nasa.gov/moon.html
Lunar & Planetary Institute (Exploring the Moon)

http://www-sn.jsc.nasa.gov/explore/explore.htm
Johnson Space Center (future human exploration)

http://ilewg.jsc.nasa.gov/
International Lunar Exploration Working Group

http://nssdc.gsfc.nasa.gov/planetary/planets/moonpage.html
National Space Science Data Center (Moon homepage)

Exploring the Moon on-line version of this publication at NASA Spacelink

**Lunar Prospector Mission**

http://lunar.arc.nasa.gov/
Homepage from NASA Ames Research Center

http://juggler.lmsc.lockheed.com/lunar/
Lunar Prospector homepage from Lockheed-Martin

http://nssdc.gsfc.nasa.gov/planetary/lunarprosp.html
National Space Science Data Center

**Planetary Exploration**

http://www.soest.hawaii.edu/PSRdiscoveries/
Planetary Science Research Discoveries web magazine

http://www.soest.hawaii.edu/spacegrant/classacts/
Hands-on classroom activities for planetary science

http://spacelink.nasa.gov/
NASA Spacelink

http://bang.lanl.gov/solarsys/
Views Of The Solar System (Calvin Hamilton/LANL)

http://seds.lpl.arizona.edu/nineplanets/nineplanets/luna.html
The Nine Planets - Moon pages (Bill Arnett/SEDS)

http://pds.jpl.nasa.gov/planets/
Welcome to the Planets (PDS/JPL)

http://stardate.utexas.edu/resources/ssguide/SSG_Contents.html
Guide to the Solar System (McDonald Observatory)

http://nssdc.gsfc.nasa.gov/imgcat/
NSSDC Planetary Image Catalog

http://photojournal.jpl.nasa.gov/
NASA Planetary Photojournal

http://nix.nasa.gov/
NASA Image eXchange (NIX)

**Apollo Mission**

http://www-sn.jsc.nasa.gov/explore/Data/Apollo/Apollo.htm
Apollo Experiment Operations

http://www.hq.nasa.gov/office/pao/History/alsj/
Apollo Lunar Surface Journal

**Clementine Mission**

http://nssdc.gsfc.nasa.gov/planetary/clementine.html
Lunar data from the Clementine Mission

http://cass.jsc.nasa.gov/publications/slidesets/clementine.html
Clementine Explores the Moon, annotated slide set

http://cass.jsc.nasa.gov/research/clemen/clemen.html
Clementine Mission - Images of the Moon
NASA Resources for Educators

NASA’s Central Operation of Resources for Educators (CORE) was established for the national and international distribution of NASA-produced educational materials in audiovisual format. Educators can obtain a catalogue and an order form by one of the following methods:

- NASA CORE
  Lorain County Joint Vocational School
  15181 Route 58 South
  Oberlin, OH 44074
  Phone: (440) 774-1051, Ext. 249 or 293
  Fax: (440) 774-2144
  E-mail nasaco@leeaca.esu.k12.oh.us
  Home Page: http://spacelink.nasa.gov/CORE

Educator Resource Center Network

To make additional information available to the education community, the NASA Education Division has created the NASA Educator Resource Center (ERC) network. ERCs contain a wealth of information for educators: publications, reference books, slide sets, audio cassettes, videotapes, teleteaching programs, computer programs, lesson plans, and teacher guides with activities. Educators may preview, copy, or receive NASA materials at these sites. Because each NASA Field Center has its own areas of expertise, no two ERCs are exactly alike. Phone calls are welcome if you are unable to visit the ERC that serves your geographic area. A list of the centers and the regions they serve includes:

AK, AZ, CA, HI, ID, MT, NV, OR, UT, WA, WY
NASA Educator Resource Center
Mail Code 130.3
NASA Goddard Space Flight Center
Greenbelt, MD 20771-0001
Phone: (301) 286-8574

CO, KS, NE, NM, ND, OK, SD, TX
JSC Educator Resource Center
Space Center Houston
NASA Johnson Space Center
1601 NASA Road One
Houston, TX 77058-3696
Phone: (281) 483-8696

FL, GA, PR, VI
NASA Educator Resource Laboratory
Mail Code ERL
NASA Kennedy Space Center
Kennedy Space Center, FL 32899-0001
Phone: (407) 867-4090

KY, NC, SC, VA, WV
Virginia Air and Space Museum
NASA Educator Resource Center for NASA Langley Research Center
600 Settler’s Landing Road
Hampton, VA 23668-4033
Phone: (757) 727-0900 x 757

IL, IN, MI, MN, OH, WI
NASA Educator Resource Center
Mail Stop 8-1
NASA Lewis Research Center
21000 Brookpark Road
Cleveland, OH 44135-3191
Phone: (216) 433-2017

AL, AR, IA, LA, MO, WV
U.S. Space and Rocket Center
NASA Educator Resource Center for NASA Marshall Space Flight Center
P.O. Box 07015
Huntsville, AL 35807-7015
Phone: (205) 544-5812

ME
NASA Educator Resource Center
Building 1200
NASA John C. Stennis Space Center
Stennis Space Center, MS 39529-6500
Phone: (228) 688-3398

MS
NASA Educator Resource Center
Building 1200
NASA John C. Stennis Space Center
Stennis Space Center, MS 39529-6500
Phone: (228) 688-3398

CA cities near the center
NASA Educator Resource Center for NASA Dryden Flight Research Center
45108 N. 3rd Street East
Lancaster, CA 93535
Phone: (661) 949-7347

VA and MD’s Eastern Shores
NASA Educator Resource Lab
Education Complex - Visitor Center Building J-1
NASA Wallops Flight Facility
Wallops Island, VA 23337-5099
Phone: (757) 824-2297/2298

Regional Educator Resource Centers (RERCs) offer more educators access to NASA educational materials. NASA has formed partnerships with universities, museums, and other educational institutions to serve as RERCs in many states. A complete list of RERCs is available through CORE, or electronically via NASA Spacelink at http://spacelink.nasa.gov

NASA On-line Resources for Educators provide current educational information and instructional resource materials to teachers, faculty, and students. A wide range of information is available, including science, mathematics, engineering, and technology education lesson plans, historical information related to the aeronautics and space program, current status reports on NASA projects, news releases, information on NASA educational programs, useful software and graphics files. Educators and students can also use NASA resources as learning tools to explore the Internet, accessing information about educational grants, interacting with other schools which are already on-line, and participating in on-line interactive projects, communicating with NASA scientists, engineers, and other team members to experience the excitement of real NASA projects.

Access these resources through the NASA Education Home Page: http://www.hq.nasa.gov/education

NASA Television (NTV) is the Agency’s distribution system for live and taped programs. It offers the public a front-row seat for launches and missions, as well as informational and educational programming, historical documentaries, and updates on the latest developments in aeronautics and space science. NTV is transmitted on the GE-2 satellite, Transponder 9C at 85 degrees West longitude, vertical polarization, with a frequency of 3880 megahertz, and audio of 6.8 megahertz.

Apart from live mission coverage, regular NASA Television programming includes a Video File from noon to 1:00 pm, a NASA Gallery File from 1:00 to 2:00 pm, and an Education File from 2:00 to 3:00 pm (all times Eastern). This sequence is repeated at 3:00 pm, 6:00 pm, and 9:00 pm, Monday through Friday. The NTV Education File features programming for teachers and students on science, mathematics, and technology. NASA Television programming may be videotaped for later use.


How to Access NASA’s Education Materials and Services, EP-1996-11-345-HQ This brochure serves as a guide to accessing a variety of NASA materials and services for educators. Copies are available through the ERC network, or electronically via NASA Spacelink. NASA Spacelink can be accessed at the following address: http://spacelink.nasa.gov
Exploring the Moon—A Teacher’s Guide with Activities for Earth and Space Sciences

EDUCATOR REPLY CARD

To achieve America’s goals in Educational Excellence, it is NASA’s mission to develop supplementary instructional materials and curricula in science, mathematics, geography, and technology. NASA seeks to involve the educational community in the development and improvement of these materials. Your evaluation and suggestions are vital to continually improving NASA educational materials.

Please take a moment to respond to the statements and questions below. You can submit your response through the Internet or by mail. Send your reply to the following Internet address:

http://ednet.gsfc.nasa.gov/edcats/teachers_guide

You will then be asked to enter your data at the appropriate prompt.

Otherwise, please return the reply card by mail. Thank you.

1. With what grades did you use the educator guide?
   Number of Teachers/Faculty:
   _____ K-4   _____ 5-8   _____ 9-12   _____ Community College
   College/University - _____ Undergraduate   _____ Graduate

   Number of Students:
   _____ K-4   _____ 5-8   _____ 9-12   _____ Community College
   College/University - _____ Undergraduate   _____ Graduate

   Number of Others:
   _____ Administrators/Staff   _____ Parents   _____ Professional Groups
   _____ General Public   _____ Civic Groups   _____ Other

2. What is your home 5- or 9-digit zip code?  __ __ __ __ __ — __ __ __ __

3. This is a valuable educator guide?
   □ Strongly Agree   □ Agree   □ Neutral   □ Disagree   □ Strongly Disagree

4. I expect to apply what I learned in this educator guide.
   □ Strongly Agree   □ Agree   □ Neutral   □ Disagree   □ Strongly Disagree

5. What kind of recommendation would you make to someone who asks about this educator guide?
   □ Excellent   □ Good   □ Average   □ Poor   □ Very Poor

6. How did you use this educator guide?
   □ Background Information   □ Critical Thinking Tasks
   □ Demonstrate NASA Materials   □ Demonstration
   □ Group Discussions   □ Hands-On Activities
   □ Integration Into Existing Curricula   □ Interdisciplinary Activity
   □ Lecture   □ Science and Mathematics
   □ Team Activities   □ Standards Integration
   □ Other: Please specify: ____________________________________________

7. Where did you learn about this educator guide?
   □ NASA Educator Resource Center
   □ NASA Central Operation of Resources for Educators (CORE)
   □ Institution/School System
   □ Fellow Educator
   □ Workshop/Conference
   □ Other: Please specify: ____________________________________________

8. What features of this educator guide did you find particularly helpful?
   ____________________________________________
   ____________________________________________

9. How can we make this educator guide more effective for you?
   ____________________________________________
   ____________________________________________

10. Additional comments:
    ____________________________________________
    ____________________________________________

Today’s Date: ____________________________  EG-1997-10-116-HQ