Module 3 – Nautical Science

Unit 4 – Astronomy

Chapter 13 - The Moon

Section 1 – The Moon

What You Will Learn to Do

Demonstrate understanding of astronomy and how it pertains to our solar system and its related bodies: Moon, Sun, stars and planets

Objectives

1. Recognize basic facts about the Moon such as size, distance from Earth and atmosphere
2. Describe the geographical structure of the Moon
3. Describe the surface features of the Moon
4. Explain those theories that describe Moon craters and their formations

Objectives

5. Describe the mountain ranges and riles on the surface of the Moon
6. Explain the effect moonquakes have on the Moon
7. Describe how the Moon's motion causes its phases
8. Explain the basic reasons for Moon exploration

Key Terms

CPS Key Term
Questions 1 - 12

Key Terms

Maria - Mare or Maria (plural);
Any of the several dark plains on the Moon and Mars; Latin word for “Sea”

Reflectance - The ratio of the intensity of reflected radiation to that of the radiation that initially hits the surface.

Key Terms

Impact Crater -	The cup shaped depression or cavity on the surface of the Earth or other heavenly bodies.
Breccia -	Rock composed of angular fragments of older rocks melded together as a result of a meteor impact.
Regolith -	The layer of disintegrated rock fragments (dust), just above the solid rock of the Moon's crust.

Key Terms

Rilles -	Cracks in the lunar surface similar to shallow, meandering river beds on the Earth.
Phases (of the Moon) -	The Moon's motion in its orbit causes its phases (progressive changes in the visible portion of the Moon).

Key Terms

Wax -	To increase in the extent of its illuminated portion before the full Moon.
Wane -	To decrease periodically in the extent of its illuminated portion after the full Moon.
Gibbous -	Convex at both edges, as the Moon when more than half full.

Key Terms

Planetshine - Sometimes the new moon is faintly visible by day, because its otherwise dark night side is illuminated by reflected Earthlight, a phenomenon called planetshine.

Eclipse (Lunar) - The obstruction of the light of the Moon by the intervention of the Earth between it and the Sun.

Opening Question

How long does it take for the moon to complete one revolution around the earth?

1.

2.

3.

(Use CPS "Pick a Student" for this question.)

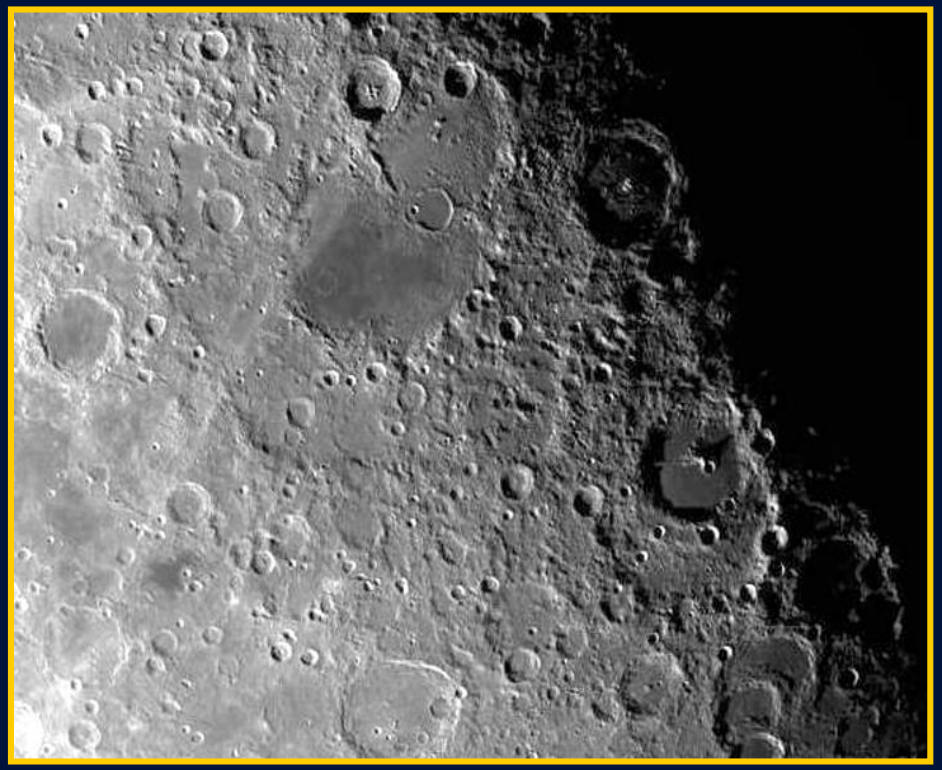
Warm Up Questions

CPS Lesson
Questions 1 - 2

Introduction

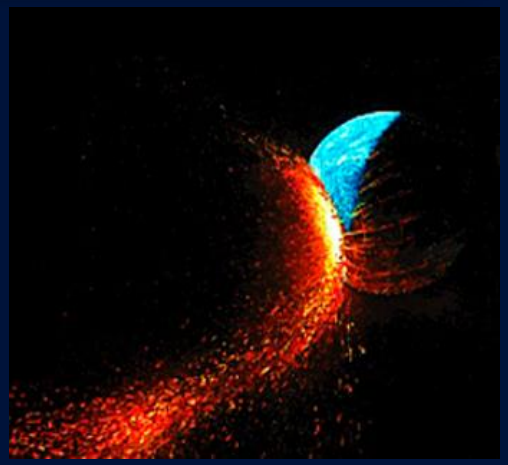
Our Moon is the fifth-largest planetary moon in the solar system.

The moon is iron-poor, with a density about the same as the Earth's mantle.



Introduction

The favored theory about when and how the Moon formed is that shortly after the Earth cooled, it was hit by a large object, causing the Earth's mantle to spew into space, eventually coming together to form the Moon.

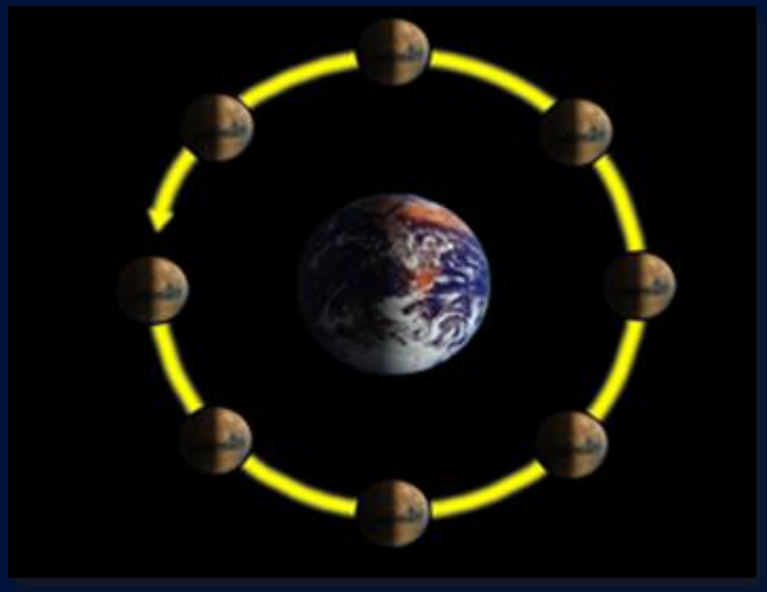


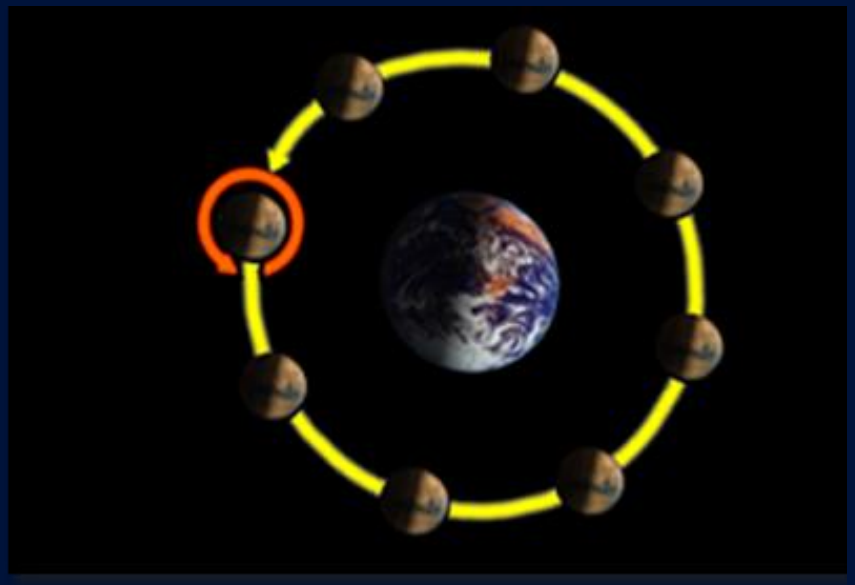
Introduction

The Moon's diameter is 2,160 miles, roughly 30 percent that of Earth.

The Moon is generally said to be about 239,000 miles away from Earth, but varies from 226,000 to 252,000 miles.

Introduction





The Moon circles the Earth every 27 1/3 days, which coincides with its rotation about its own axis. This causes the same side of the Moon to face the Earth at all times.

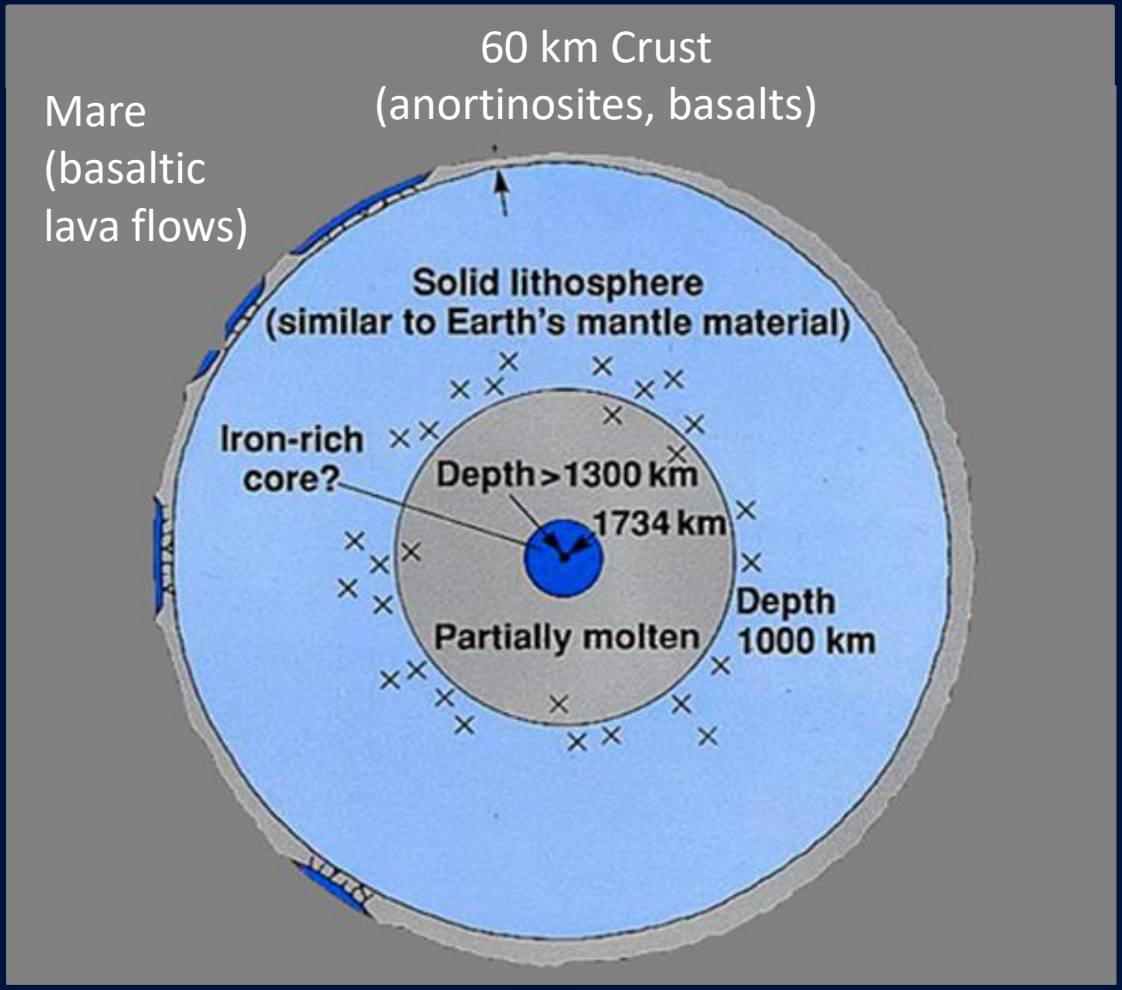
Introduction

The Moon has no atmosphere, and the Moon's sunlit surface can reach up to 243 °F and then dip to as low as -261 °F during a lunar night.

Since there is no atmosphere on the Moon, there is no sound, and a person can see twice as many stars in the sky as on Earth.

Introduction

The Moon may have a cold exterior shell (lithosphere) 250 - 265 miles thick that surrounds a warm belt or possibly a molten core.



Check On Learning Questions

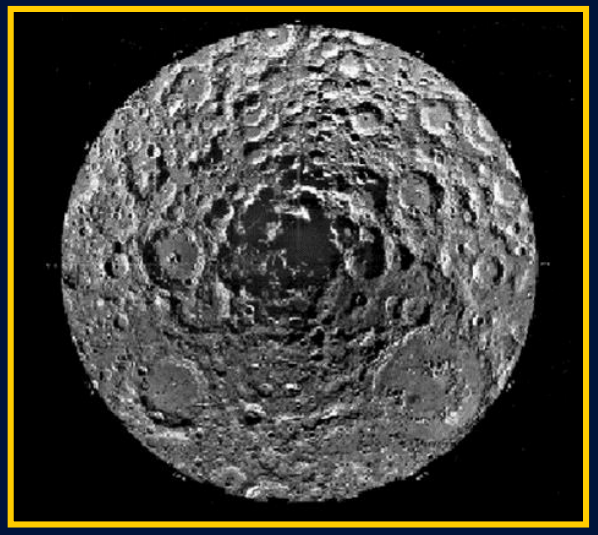
CPS Lesson

Question

3 - 4

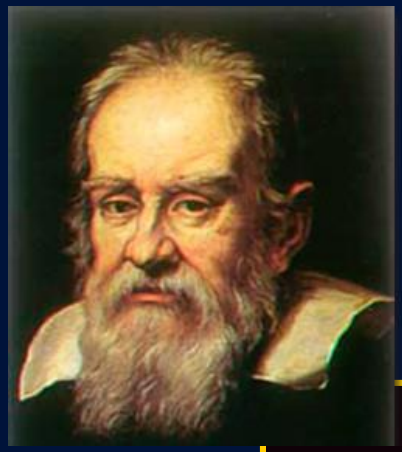
Moon Geology

The surface of the Moon is full of craters, some of which have been visible for centuries.



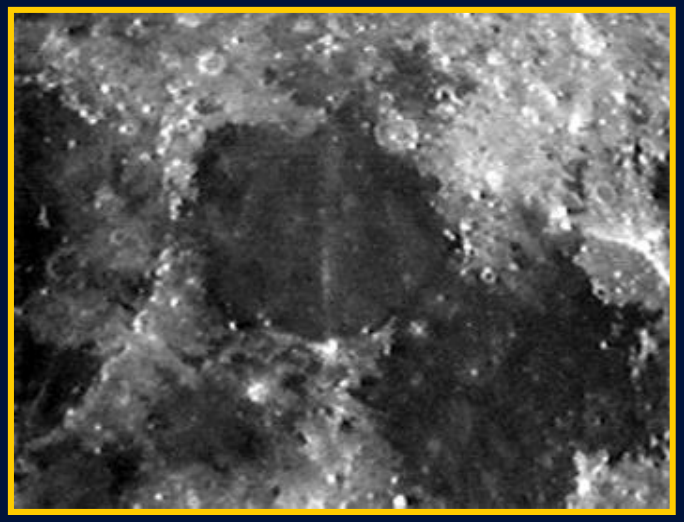
The Moon also has smooth plains and mountain ranges.

Moon Geology



Galileo mistook the lunar plains (maria) for bodies of water.

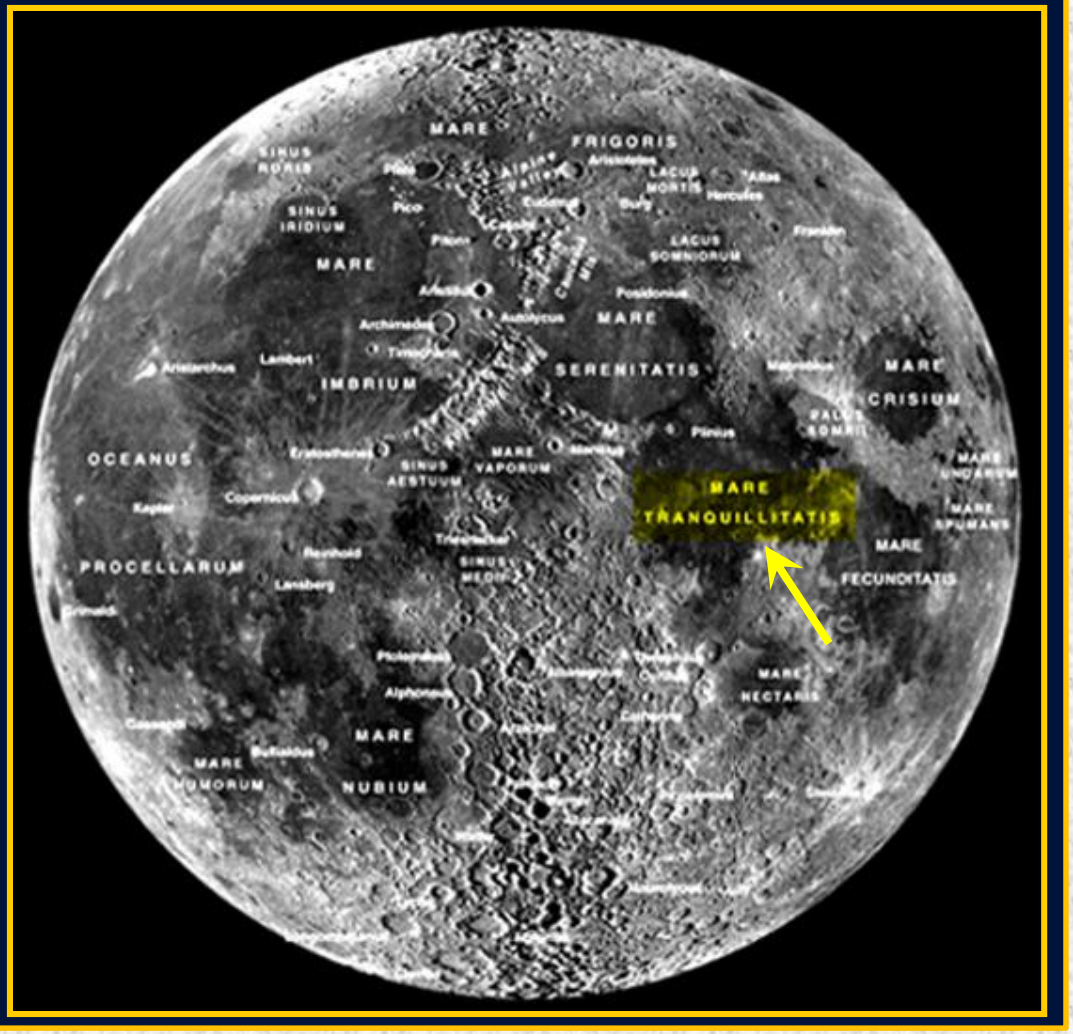
Mare



Moon Geology

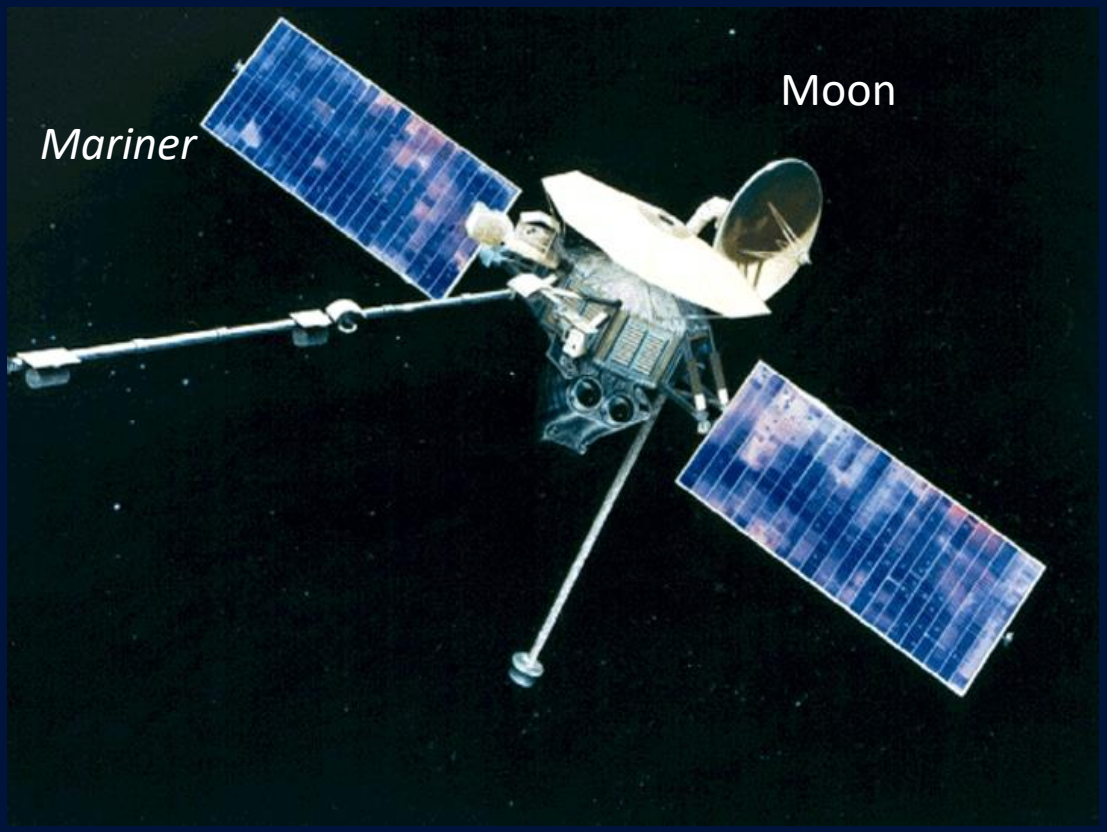
Sea of Tranquility

The great black mare is younger than the rest of the Moon.



Moon Geology

It is believed that some maria may have an iron asteroid below their surface, causing a greater magnetic field.

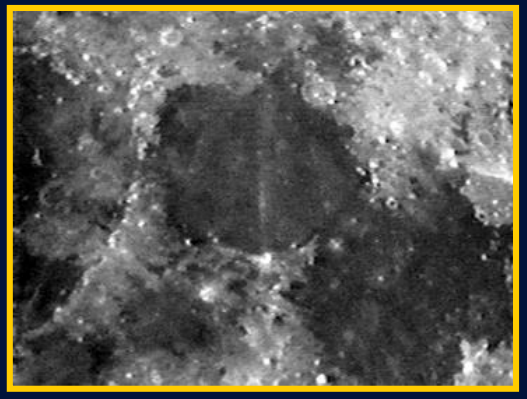


Moon Geology

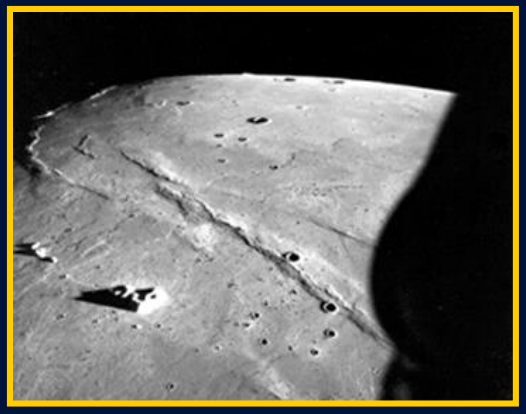
It is believed that mascons lie buried below the lunar surface.

Mare Humorum

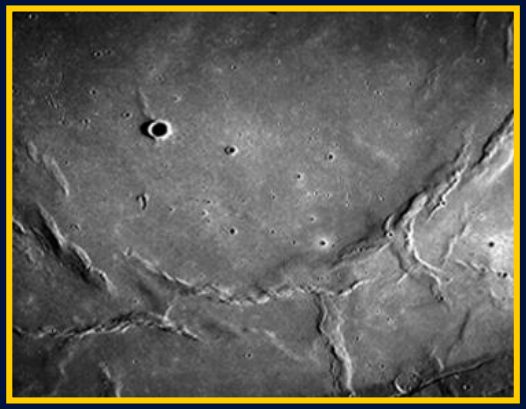
Mare Tranquillitatis



Mare Imbrium



Mare Serenitatis



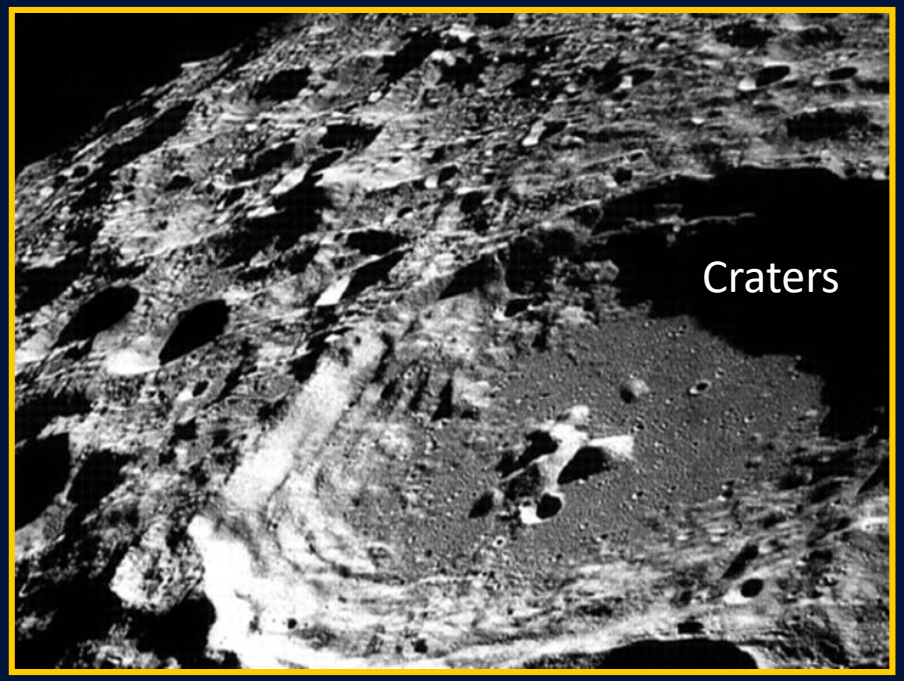
Moon Geology

Through a telescope, maria appear much darker than the craters or mountains due to a lower reflectance.

Moon Geology

There are differing theories on how the craters were formed:

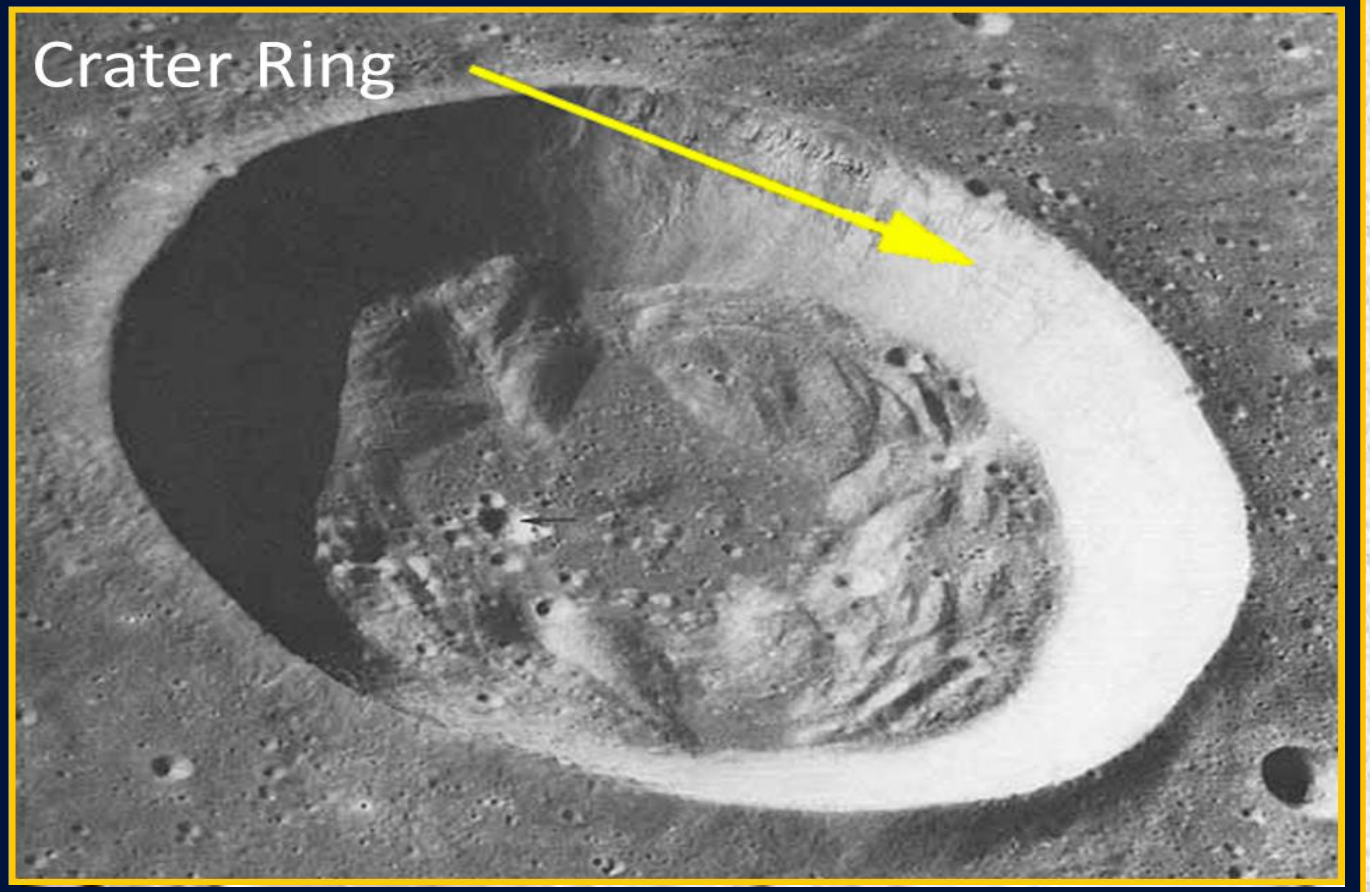
- By the impact of huge meteorites
- By volcanic action
- By the bubbling action of the molten Moon as it cooled



Moon Geology

The largest crater on the near side, Bailey, has a diameter of 183 miles.

The typical crater has a surrounding ring, ranging from 1,000 feet to 20,000 feet high.



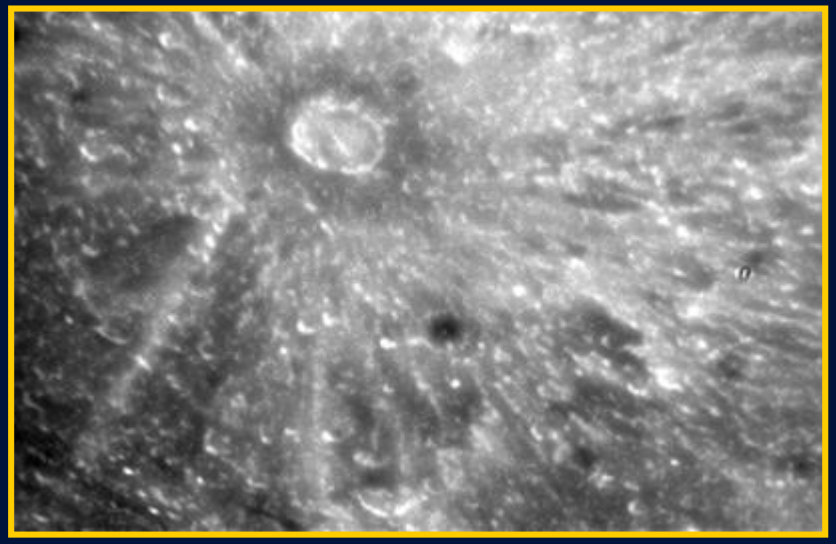
Moon Geology

Some moon craters compare to volcanic craters on Earth.

Often a central peak remains in the center of such craters, such as in Crater Lake, Oregon.

Moon Geology

Tycho Crater



In the Moon's southern hemisphere, Tycho has a great system of rays, which radiate as far as 1,500 miles out from the edges of the crater.

Moon Geology

Copernicus Crater

Rays are thought to be fine surface material that was splattered out of the most recent impact craters when they were formed.

Check On Learning Questions

CPS Lesson

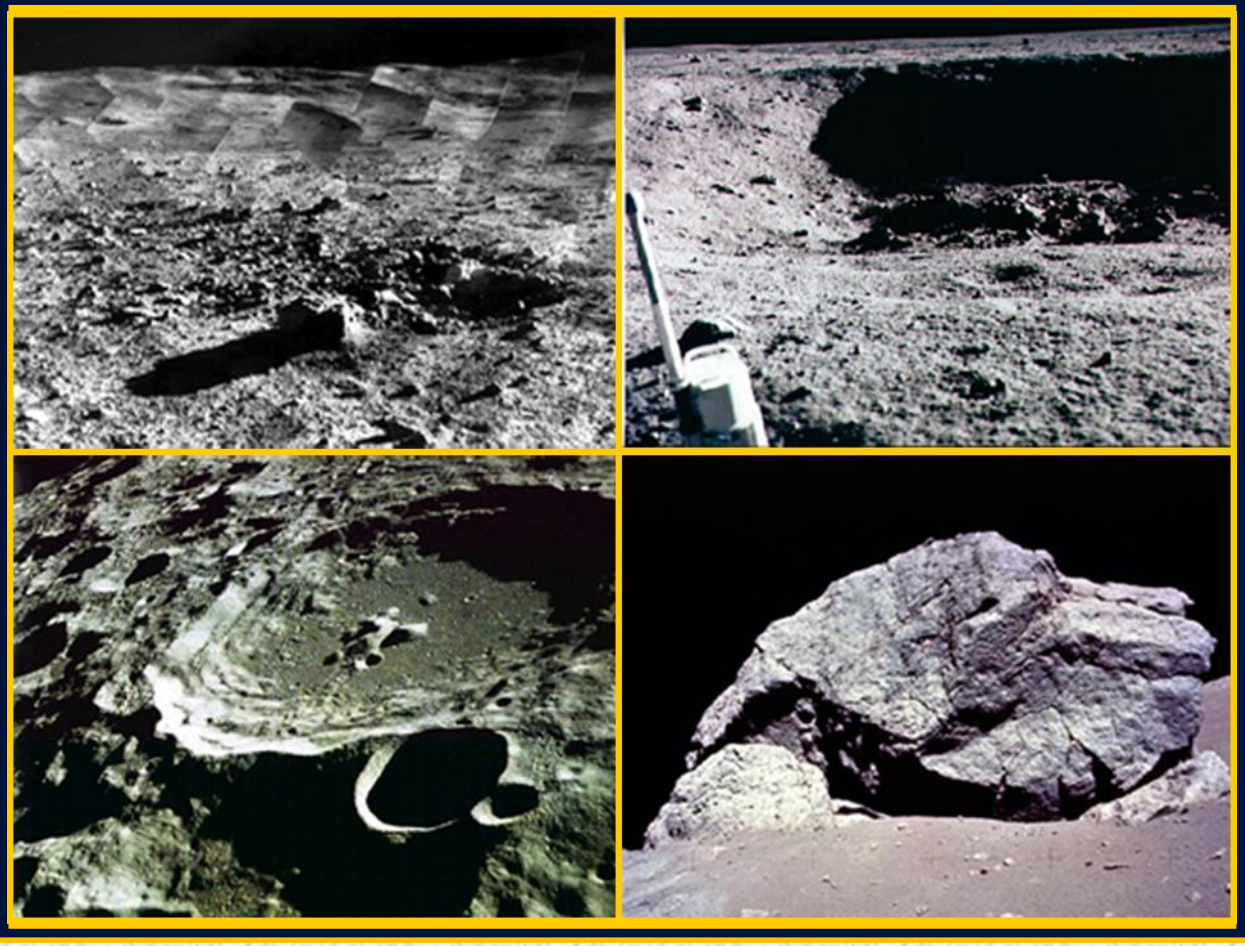
Question

5 - 6

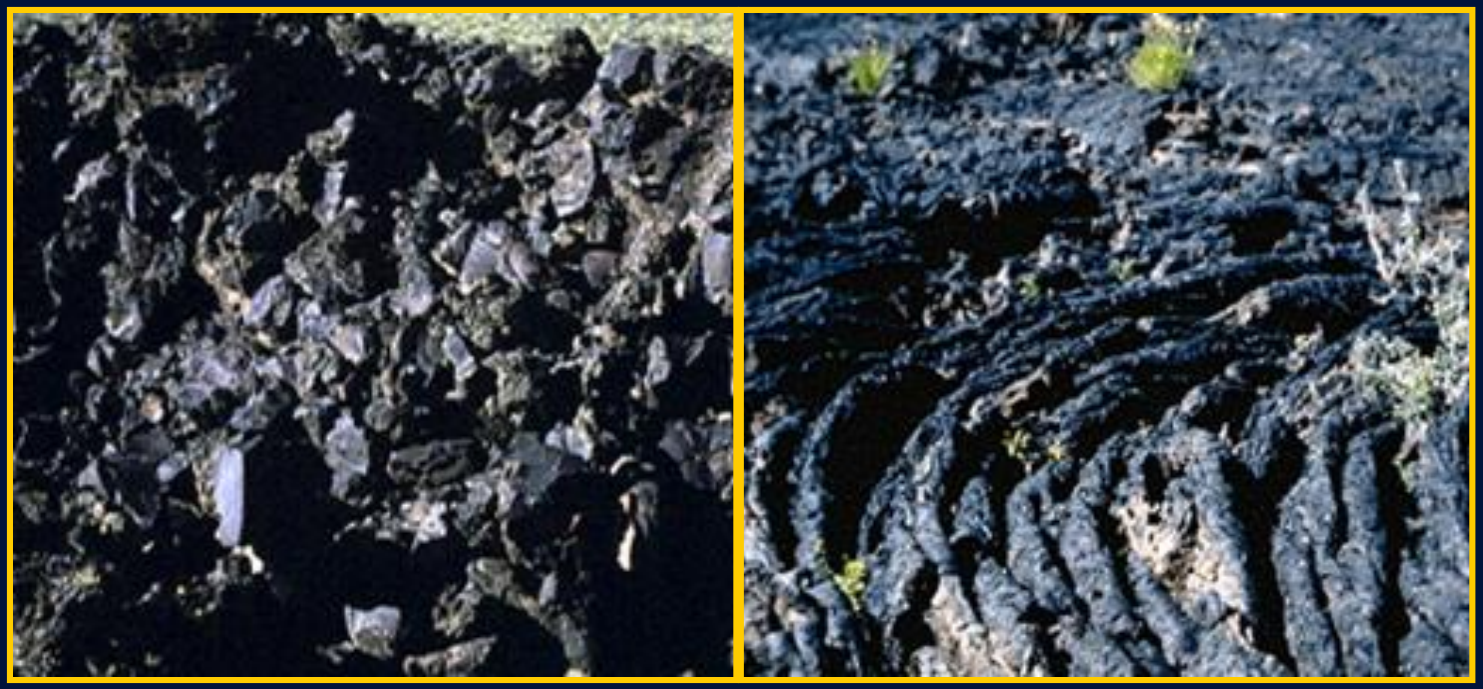
Other Surface Features

Astronauts learned that the spray of breccia on the Moon has caused extensive erosion.

Breccia



Other Surface Features



Igneous rocks have been found on the Moon.

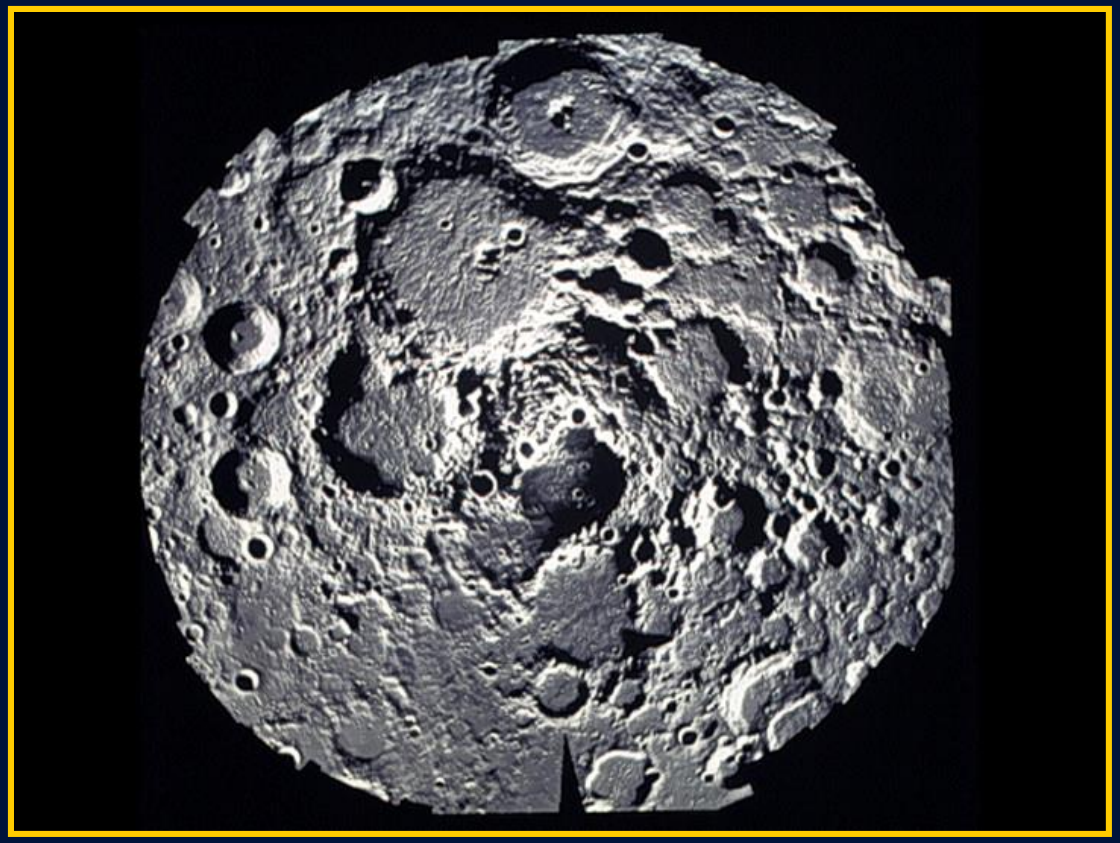
Other Surface Features

Regolith

This lunar dust layer is so deep, that for millions of years meteorites have not penetrated it.

Moon Mountains and Rilles

The Moon's mountain ranges lie in great arcs bordering the circular maria.

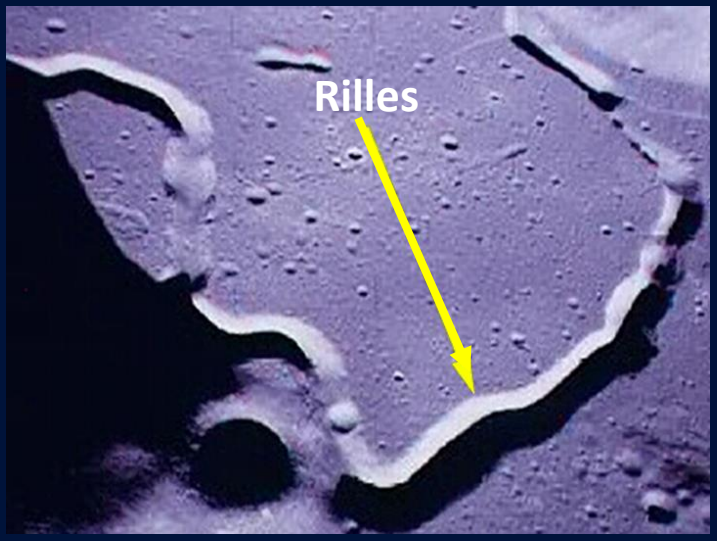


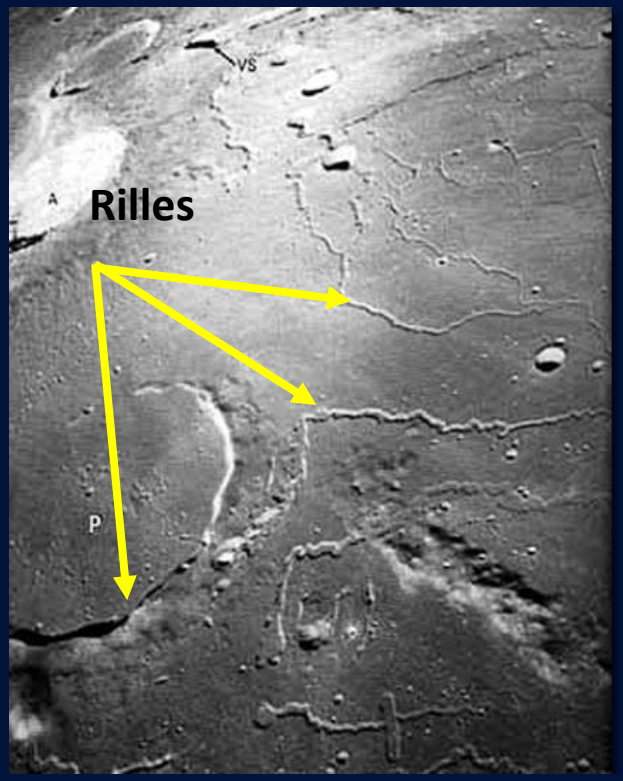
Moon Mountains and Rilles

Concentrated in the Moon's southern hemisphere, their rugged peaks sometimes rise more than 20,000 feet above the plains.

Moon Mountains and Rilles

The Moon's surface is covered with many cracks, called rilles.

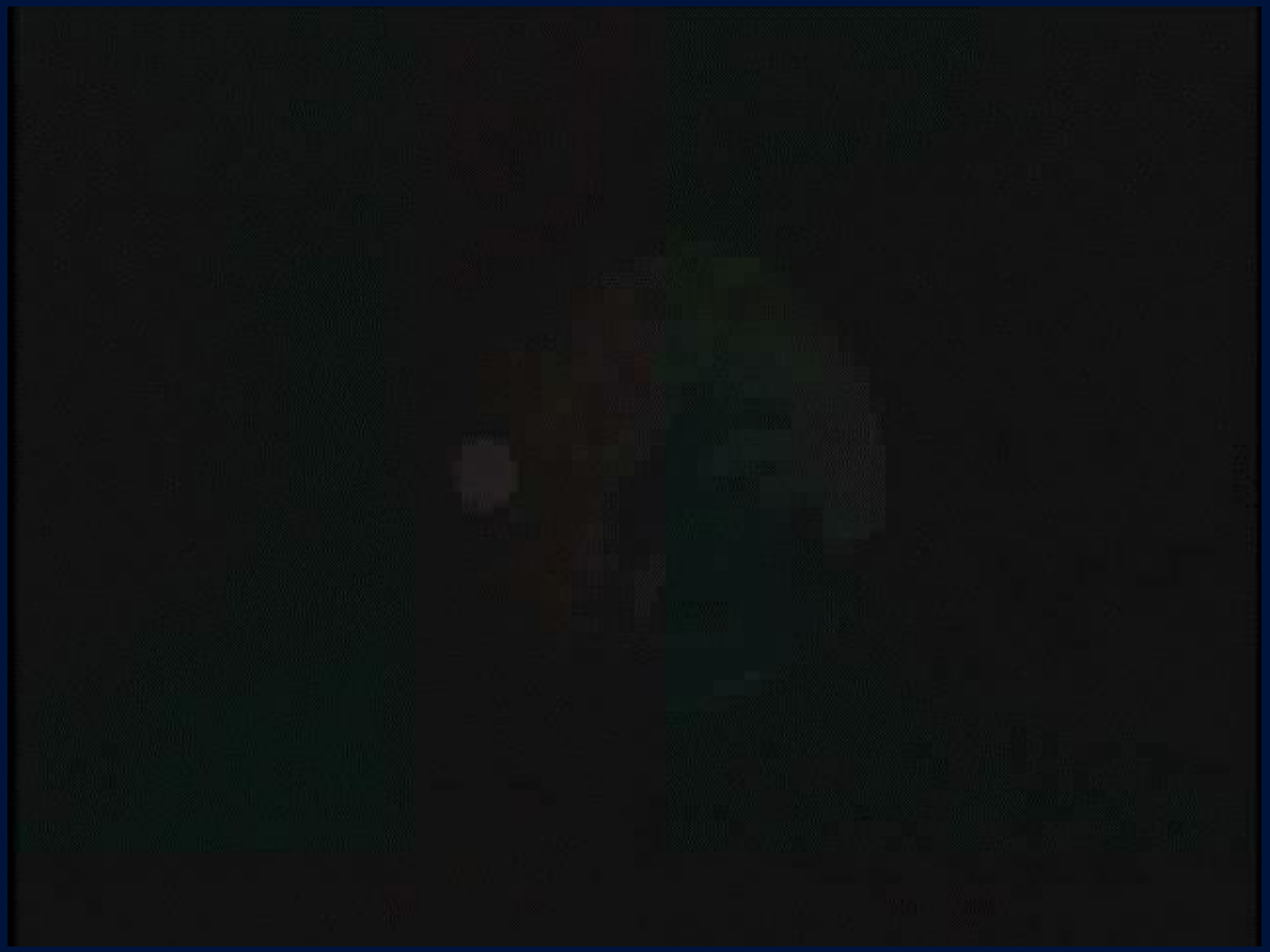




Rilles are similar to shallow, flat-bottomed riverbeds on Earth.

Phases of the Moon

Phases of the Moon



Phases of the Moon

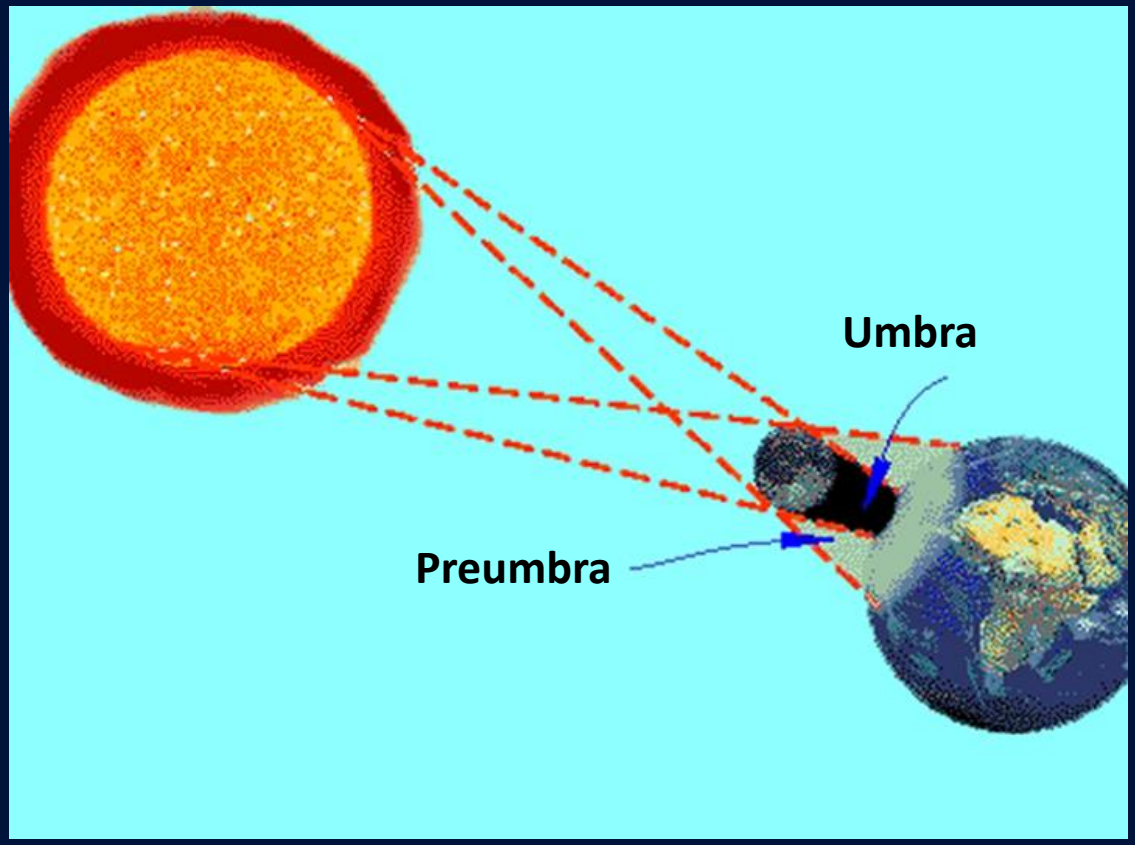
Moonrise

Sunset

The full moon rises in the east as the Sun sets in the west. Thus, we see it all night.

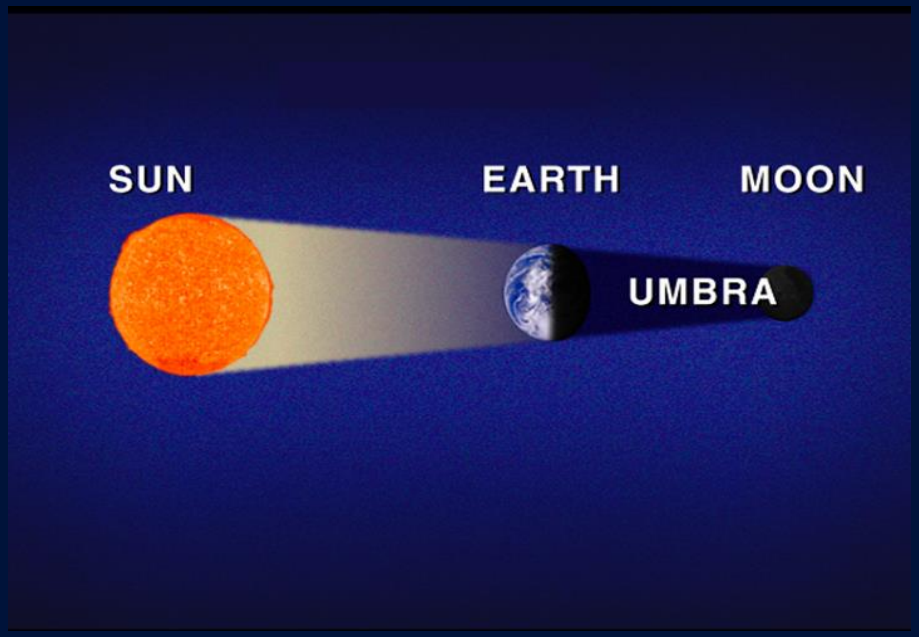
Phases of the Moon

The Earth and Moon both cast cone-shaped shadows in space.



Phases of the Moon

Lunar Eclipse



A lunar eclipse is when the Moon passes through the conical shadow of the Earth

Phases of the Moon

Lunar Eclipse

Phases of the Moon

Moon

Near Side

Far Side

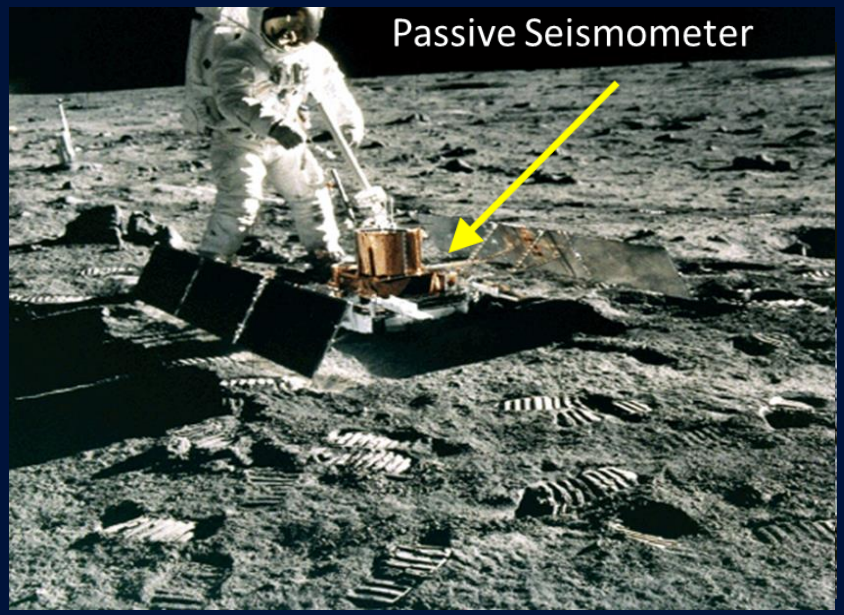
Lunar Exploration Efforts

The Apollo manned lunar landing program ran from 1961 to 1972.

Apollo 11 landed the first humans on the Moon with Americans Neil Armstrong and Buzz Aldrin, taking the first steps onto the Sea of Tranquility on July 20, 1969.

Lunar Exploration Efforts

Apollo 11 astronauts set up a moonquake detector, called a passive seismometer.



Moonquakes are unlike earthquakes. They cause the whole Moon to vibrate for hours.

Three weeks after placement, the Tranquility Base seismometer had recorded 25 different tremors on the Moon's surface.

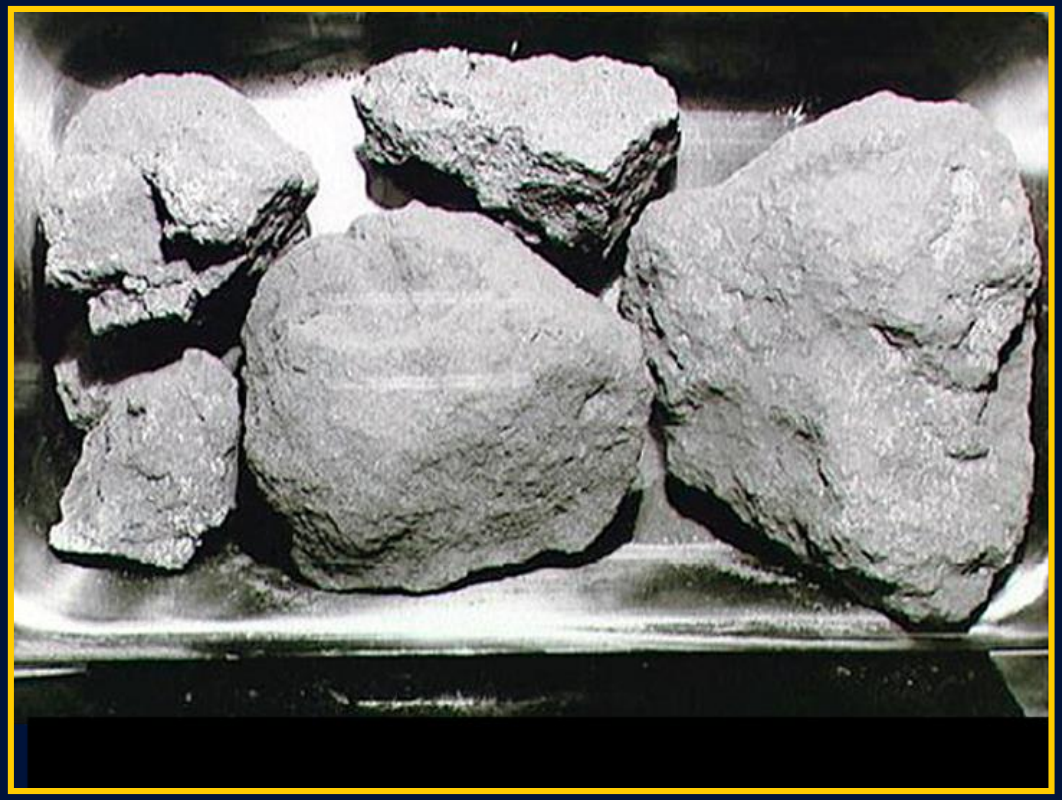
Lunar Exploration Efforts

The Apollo missions brought back some 2,200 samples (altogether 382 kg, 842 pounds) of Moon rocks and soil for later analysis.

Lunar Receiving Laboratory of NASA

Lunar Exploration Efforts

Rock samples or moon rocks were found to be rich in iron, titanium, and magnesium but completely lacking in the hydrated minerals common in Earth rocks.



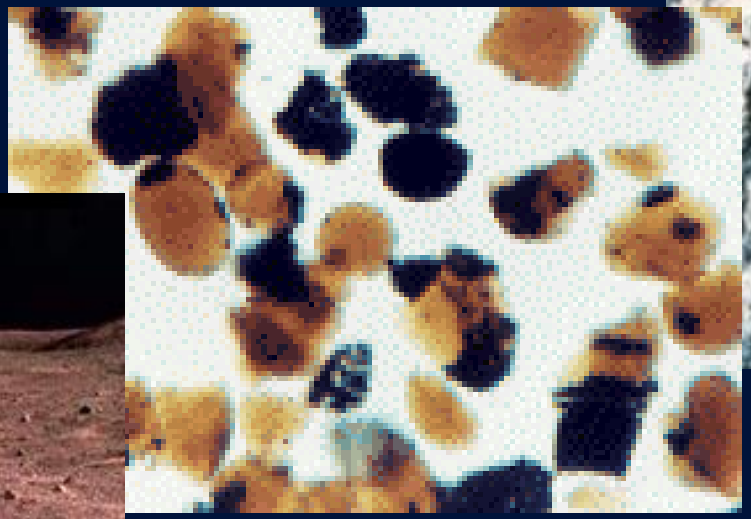
Lunar Exploration Efforts

Analysts found about sixty elements in the soil samples, which were determined to be rich in glass breccias and tiny glass tektites (beads) formed by meteorite impacts on the lunar surface.

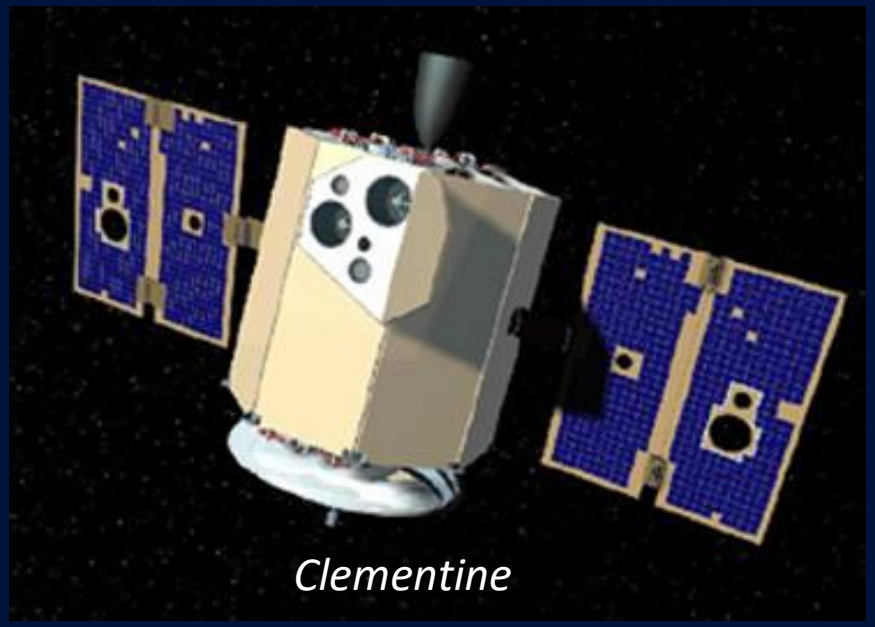
Tiny particles of tektites are no larger than a grain of sand, and make up 25% to 33% of the lunar dust.

Lunar Exploration Efforts

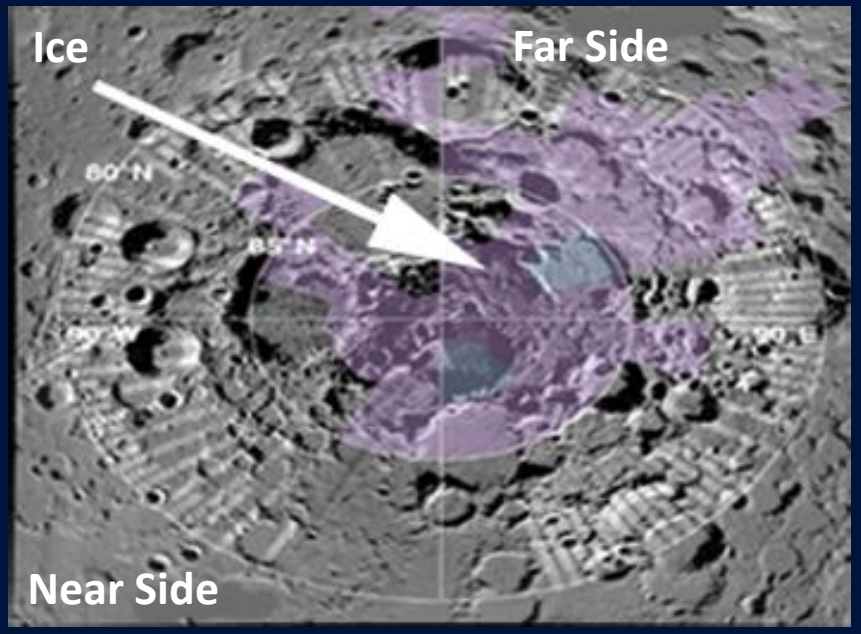
Some lunar dust sparkles with colorful crystals.



Lunar Exploration Efforts



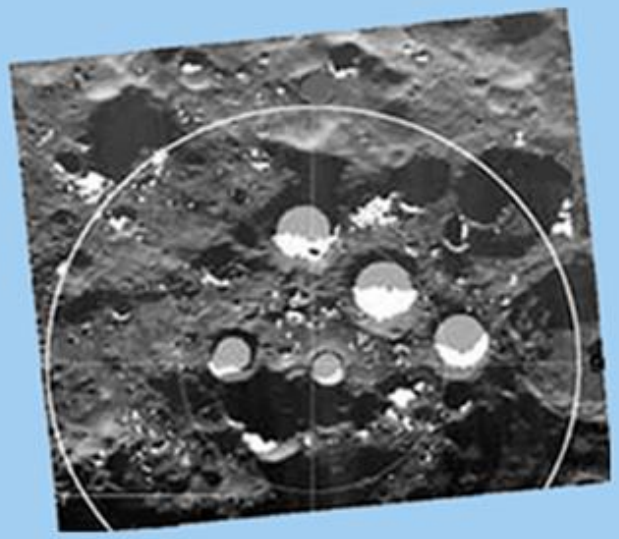
Clementine

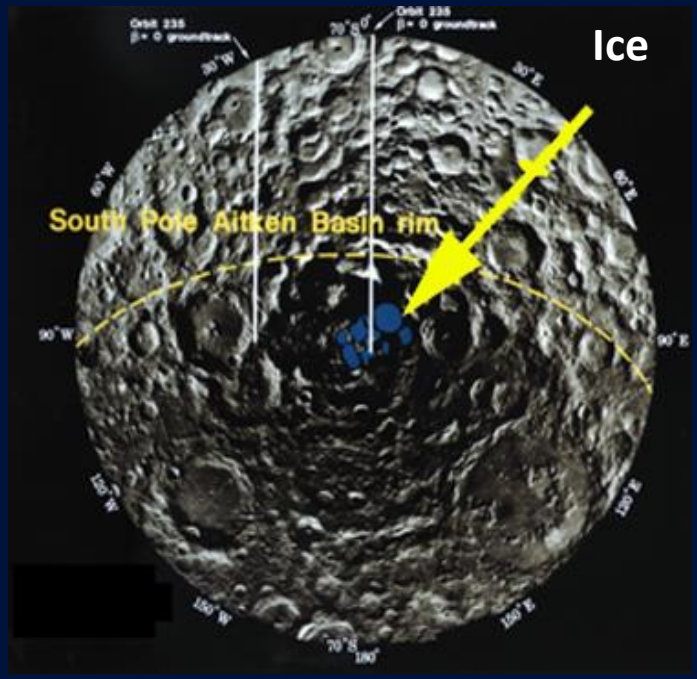


Radar signals from *Clementine* indicated the presence of ice in a large shady crater near the Moon's south pole.

Lunar Exploration Efforts

South Pole



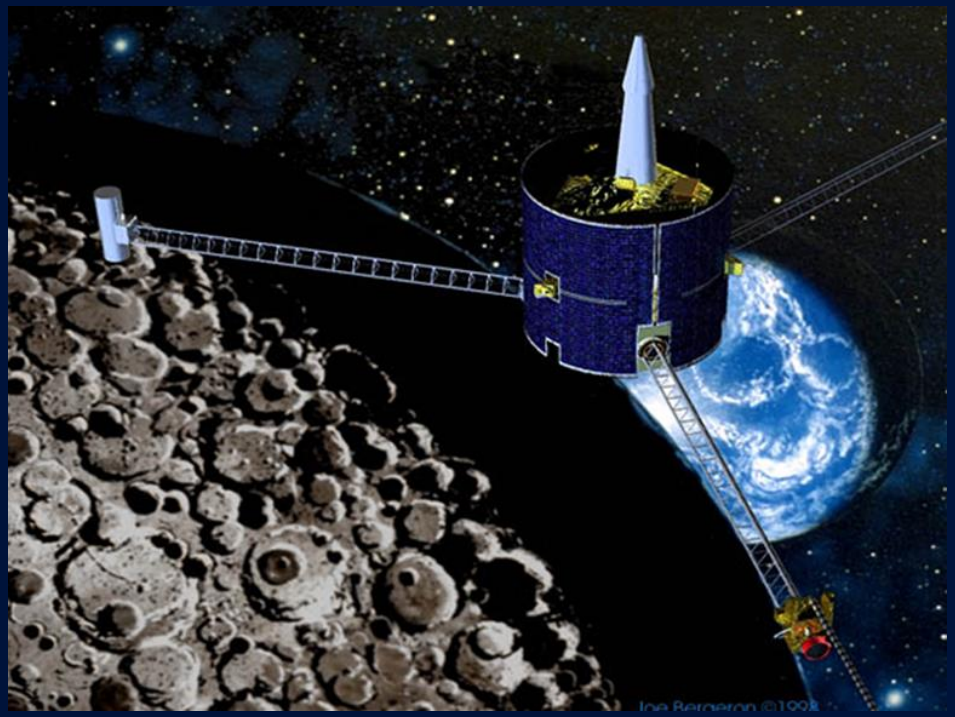


If ice exists on the moon, then the ice could be used by explorers as potable water and fuel.

Lunar Exploration Efforts

Placed in orbit around the Moon in January 1998, it was equipped with a neutron spectrometer to detect the presence of hydrogen plus nine other elements.

Lunar Prospector



It orbited at an altitude of 1,000 kilometers above the Moon and produced a detailed surface map.

Lunar Exploration Efforts

Lunar Prospector

After completing its mission in July 1999 it was intentionally crashed into a crater at the lunar south pole, in search of frozen water.

The crash of Lunar Prospector into the Moon did not liberate detectable signatures of frozen water.

Lunar Exploration Efforts

Lunar Reconnaissance Orbiter

In 2009, the U.S. launched a *Lunar Reconnaissance Orbiter* spacecraft to orbit around the Moon to:

- Identify safe landing sites for future rover missions
- Make a 3-D map of the entire lunar surface
- Look for water ice in the polar regions
- Serve as a communications relay for any possible future expeditions to the surface

Lunar Exploration Efforts

LADEE

In September 2013, NASA launched an orbiter called the Lunar Atmosphere and Dust Environment Explorer (LADEE) on a seven-month mission to study the tenuous lunar atmosphere and dust of the lunar surface. That mission also ended with an intentional plunge into the surface.

Why Explore the Moon?

Many questions still remain about the Moon:

- Its origin
- How it formed
- What it is made of
- How it evolved

The *Lunar Prospector* mission of 1998-99 has answered some of these questions.

Why Explore the Moon?

The many practical reasons to explore the moon include:

- It has mineral wealth to mine.
- It can serve as a laboratory for further exploration of the stars and planets.
- It’s an ideal place to train space explorers.
- It can provide a base of operations for further exploration of the solar system.

Why Explore the Moon?

Advantages of a base on the Moon:

- Laboratories and observatories would be unhindered by atmosphere.
- Communication relays and transportation control stations could serve in a variety of ways.
- Military applications are sure to be developed.

Review Question

Discuss the reasons and benefits for moon exploration

1.

2.

3.

(Use CPS “Pick a Student” for this question.)

Closing Questions

CPS Lesson
Questions 7 - 8

Questions?