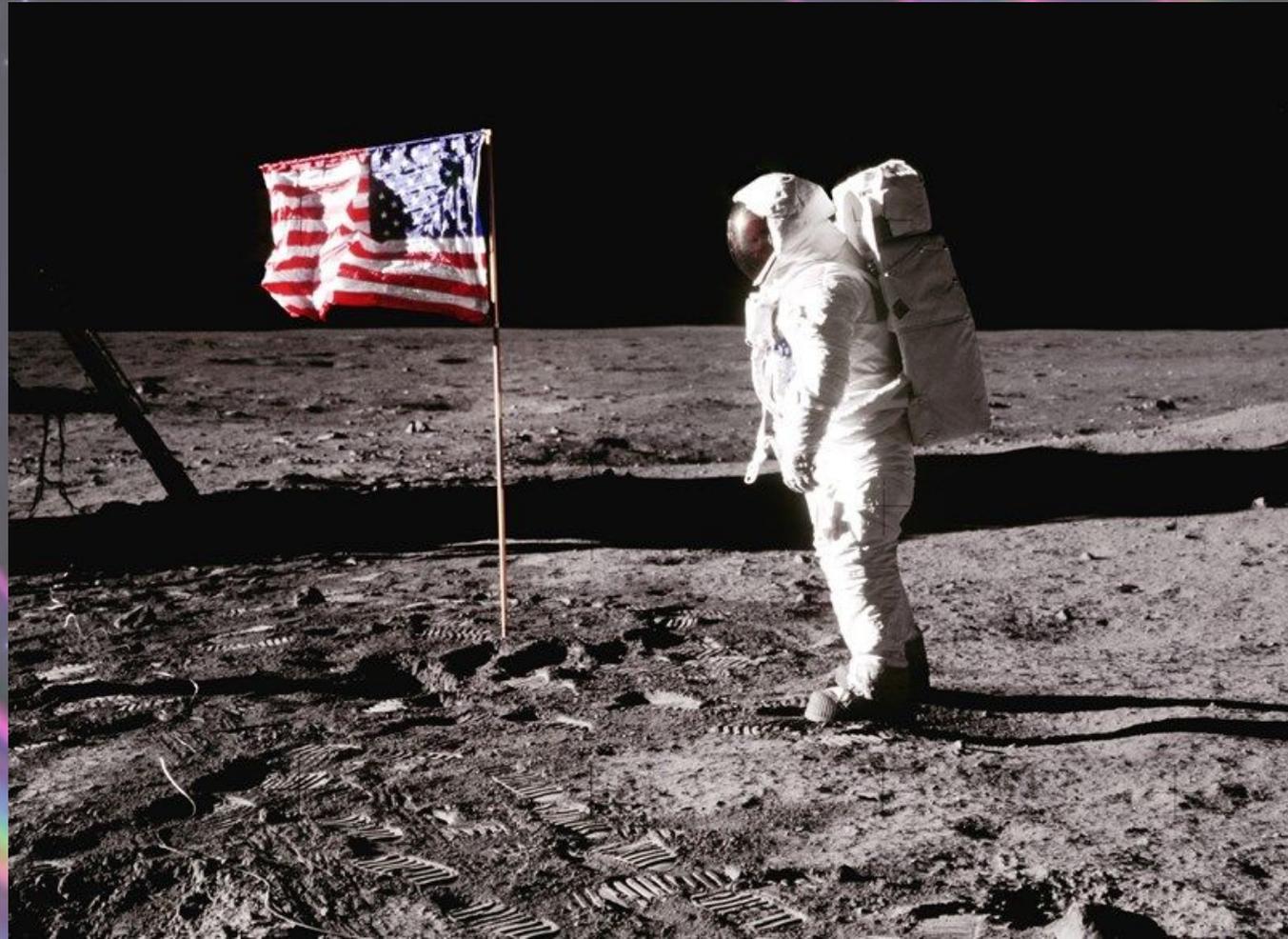


Where did the Moon come from?



Lunar Exploration



How did we study the Moon?

For hundreds of years, the telescope...

But - The Luna series was a series of lunar probes sent out by the former Soviet Union.

- **Luna 1 had the first successful flyby before going into orbit around the Sun.**
- **Luna 2 crashed into the Moon.**
- **Luna 3 orbited the Moon and sent the first close up pictures of the Moon's surface and the first pictures of the far side of the Moon.**

How did we study the Moon?

- Meanwhile, back in the USA -
- The Pioneer space probes were launched by the United States the same time the Luna space probes were in progress.
 - All Pioneers 1,2, and 3 were successful in their mission.
 - Pioneer 4 reached escape velocity from Earth and sent data back to Earth as it passed the Moon.

How was JFK involved?

- In 1961 President John F. Kennedy made it a national goal to land an astronaut on the Moon and return the astronaut safely to Earth.
- Lunar probes Ranger and Surveyor were sent to search for a safe landing site on the Moon. They were designed to send back pictures of the Moon's surface then crash into it.



Were the Russians ahead of us?

- **1957:** The Soviet Union launched the first artificial satellite (*Sputnik I*)
- **April 12th, 1961:** Yuri Gagarin, Russian cosmonaut, was the first human in space.
- The former Soviet Union had orbited a cosmonaut and also had a cosmonaut, Gherman Titov, complete a 17 orbit flight that lasted over 25 hours.
- **Voshkod II – March 18, 1965 – Alexei Leonov conducts first space walk (EVA).**

How was the US progressing?

The Mercury missions (1959-1963):

The "Right Stuff"

- Alan Shepard – 1st American in space

- John Glenn – 1st to orbit Earth

The Gemini missions (1963-1966):

- Two astronauts

- Extended time, EVA, rendezvous, etc.

Apollo stage (1967-1972)

- Get to the Moon, land on it, come back

Are there any similarities?

Earth



7930 miles diameter
23 degree axis tilt (seasons!)
Surface temps -120 to 120°F
Thick atmosphere of nitrogen
and oxygen, mild
greenhouse effect
Lots of liquid water on surface

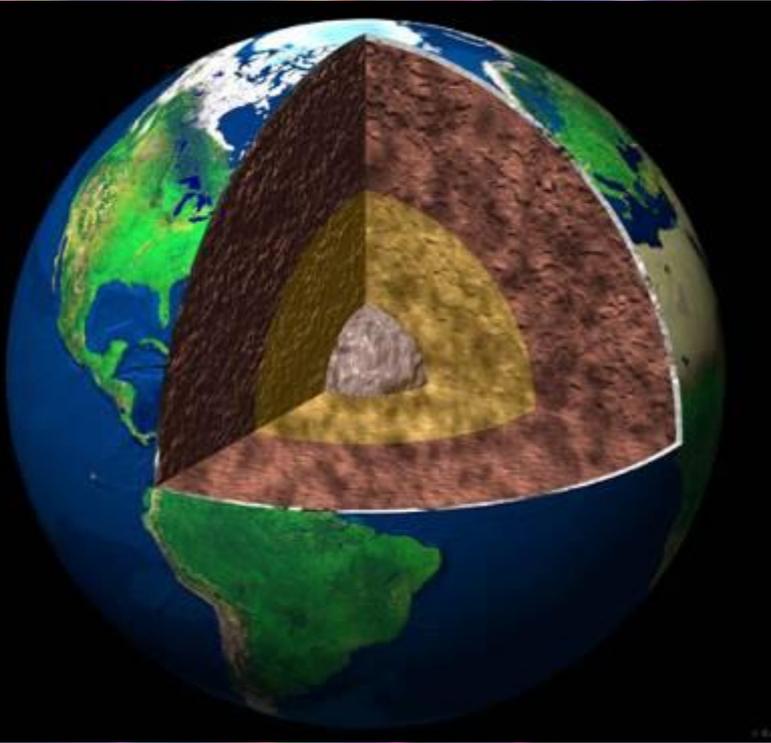
Moon



2160 miles diameter
7 degree tilt (~no seasons)
Surface temps -224 to -243°F
No atmosphere
No liquid water, ice at poles in
shadows?

Are there any similarities?

Earth



Magnetic Field – from
(liquid Fe/Ni core)
Hot, dense core
Plate tectonics, thin crust

Moon



No Magnetic Field
Small Moon Quakes
Small, Offset Core

What's the lunar surface like?

Low Albedo (7%)

Highlands

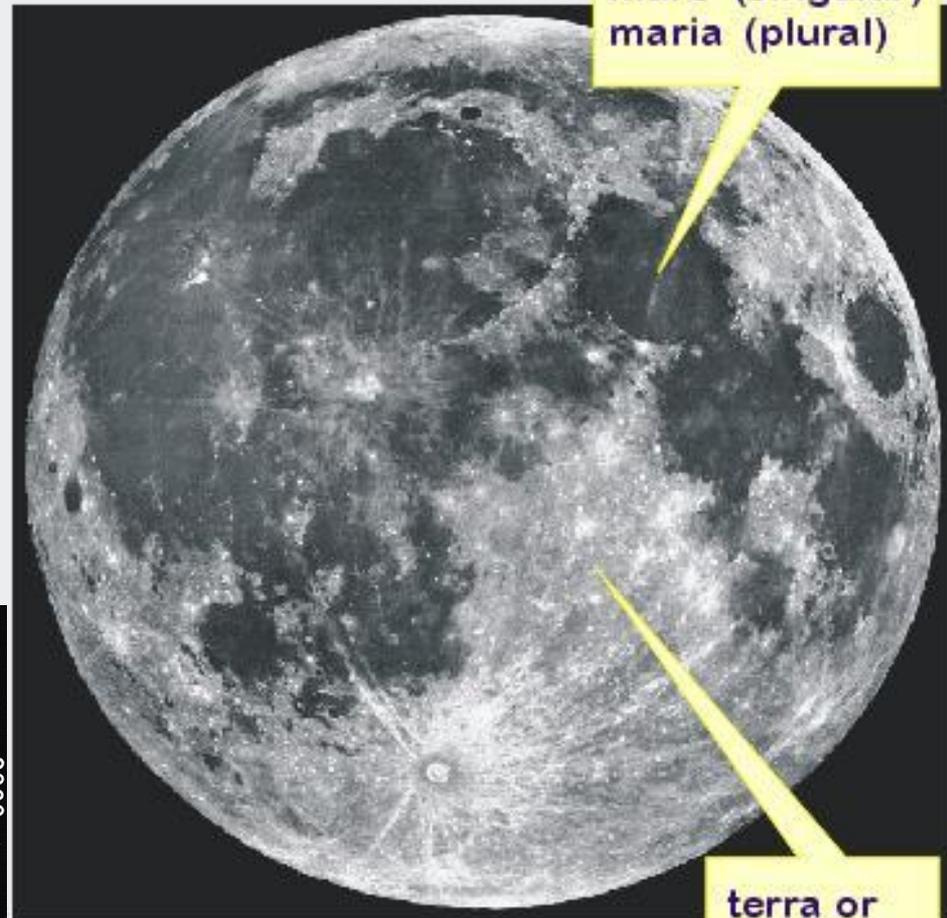
Maria

Rilles

Impact craters

Ejecta

Rays



What makes the Moon unique amongst other moons in our solar system?

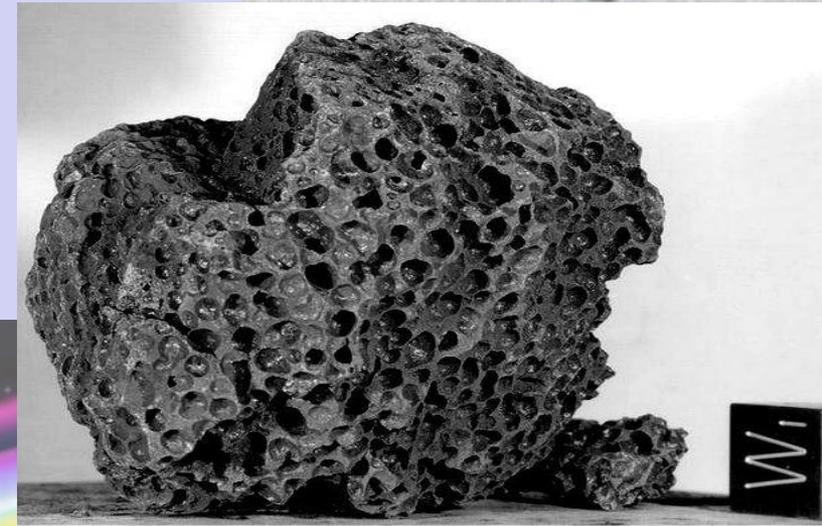
- **It's the largest moon compared to the radius and mass of the planet it orbits (used to be Pluto-Charon).**
- **It is a solid, rocky body, in contrast with the icy composition of many moons of Jupiter, Saturn, Uranus, Neptune.**
- **Its orbit is farther from Earth relative to the distance of many moons from their host planet.**

What did we learn about the Moon's composition from lunar rock samples?

- Made up of minerals similar to Earth's:

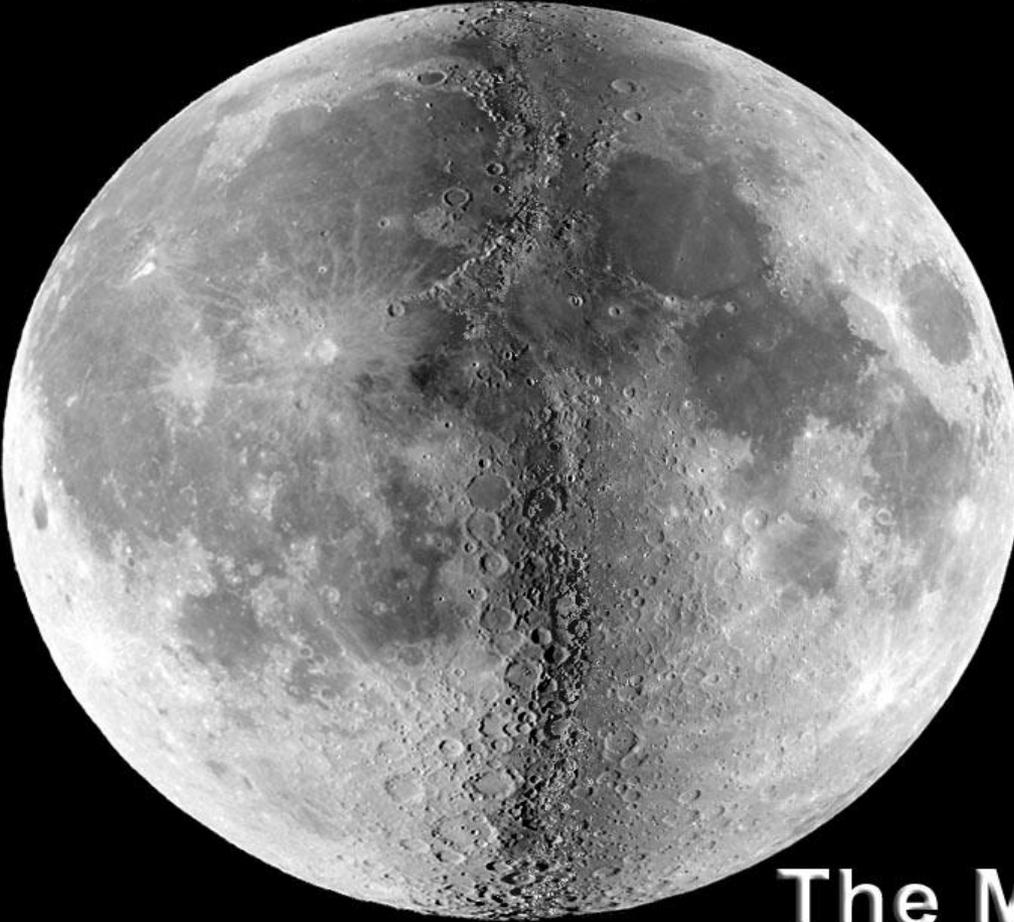
Silicates

- Highlands: Predominantly **BRECCIAS**
 - Rocks consisting of angular fragments that are cemented together.
 - Composed of plagioclase feldspar (Ca, Al rich)
- Maria: Predominantly **BASALT** (no water)

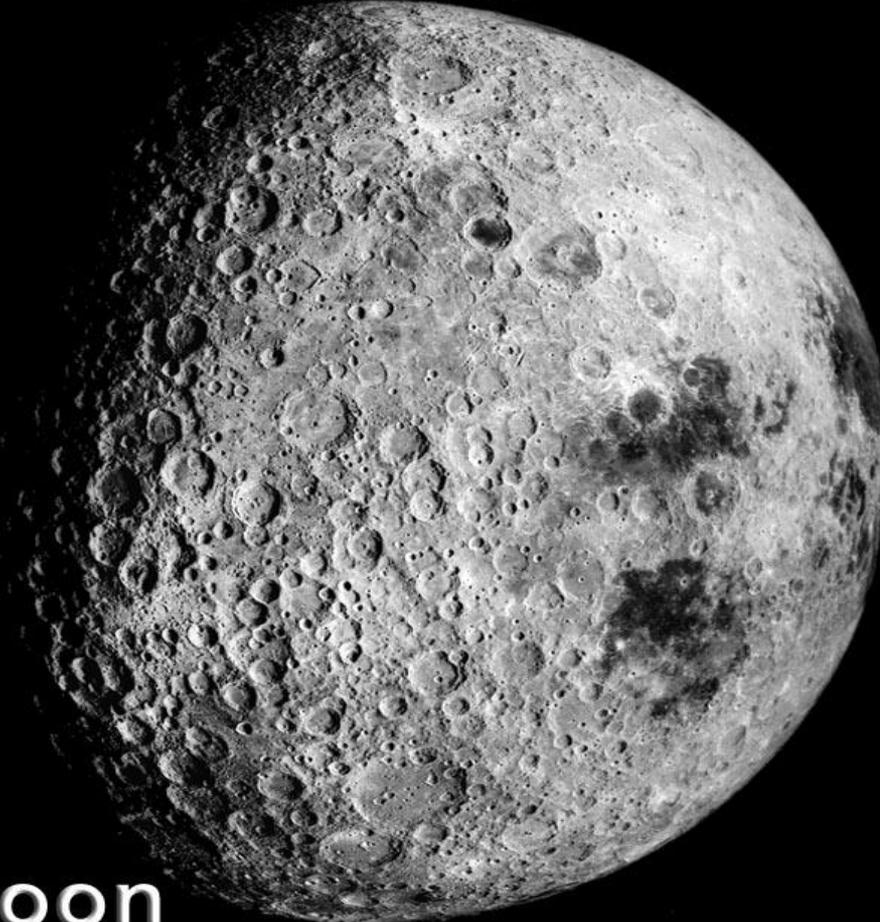


How different do the two sides of the Moon look?

Near Side



Far Side



The Moon

What is that “one small step” preserved in?

Because the Moon was heavily bombarded during its its' early life – the impacts caused breaking and heating of surface rocks and resulted in **REGOLITH** on the surface:

REGOLITH is a layer of loose, ground-up rock on the surface – includes dust, soil, broken rock, and other materials, averages several meters in thickness.



A few points to ponder while you do this next MEL

The Moon's lower density –
“lighter” - relative to terrestrial
planets

Less iron than whole Earth, more
aluminum and titanium

Moon's chemical signature ~
Earth's mantle

Doesn't orbit in equatorial plane of
Earth (ecliptic)

Earth/Moon - high angular
momentum – gets farther from
Earth each year (Earth's rotation
slows as a result).





**How did the Moon form? Where did it
come from? Let's do the MEL...**