

# Earth's Moon and Mercury

Chapter 9

# The Moon and Mercury?

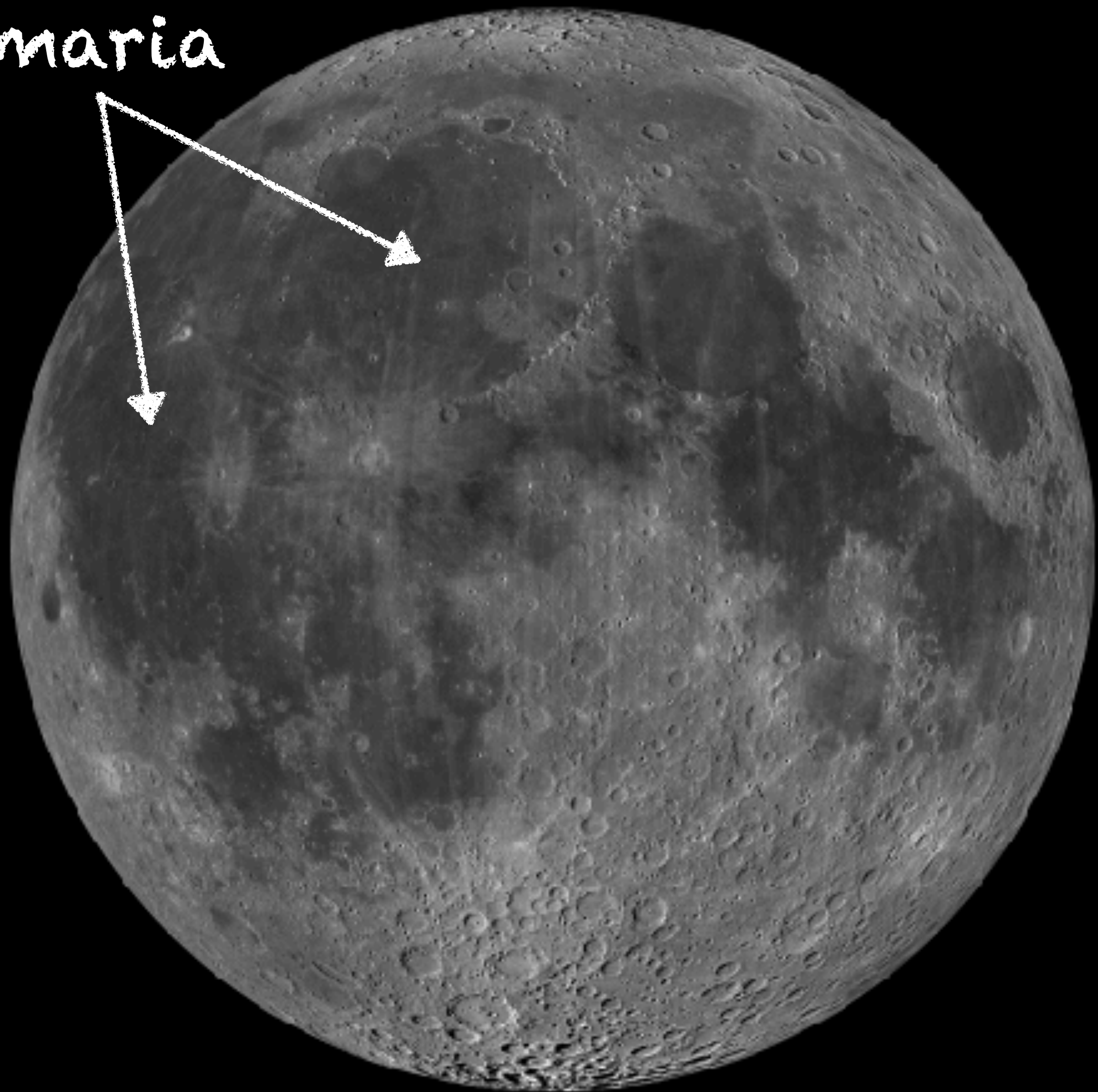
- Why are we grouping Earth's Moon and Mercury together.
- One is a moon and one is a planet. But as one of the biggest moons and the smallest planet the two actually have many similarities.
- They also have differences, but as solar system bodies go they are pretty alike so it makes sense to group them together.

# Earth's Moon (Luna)

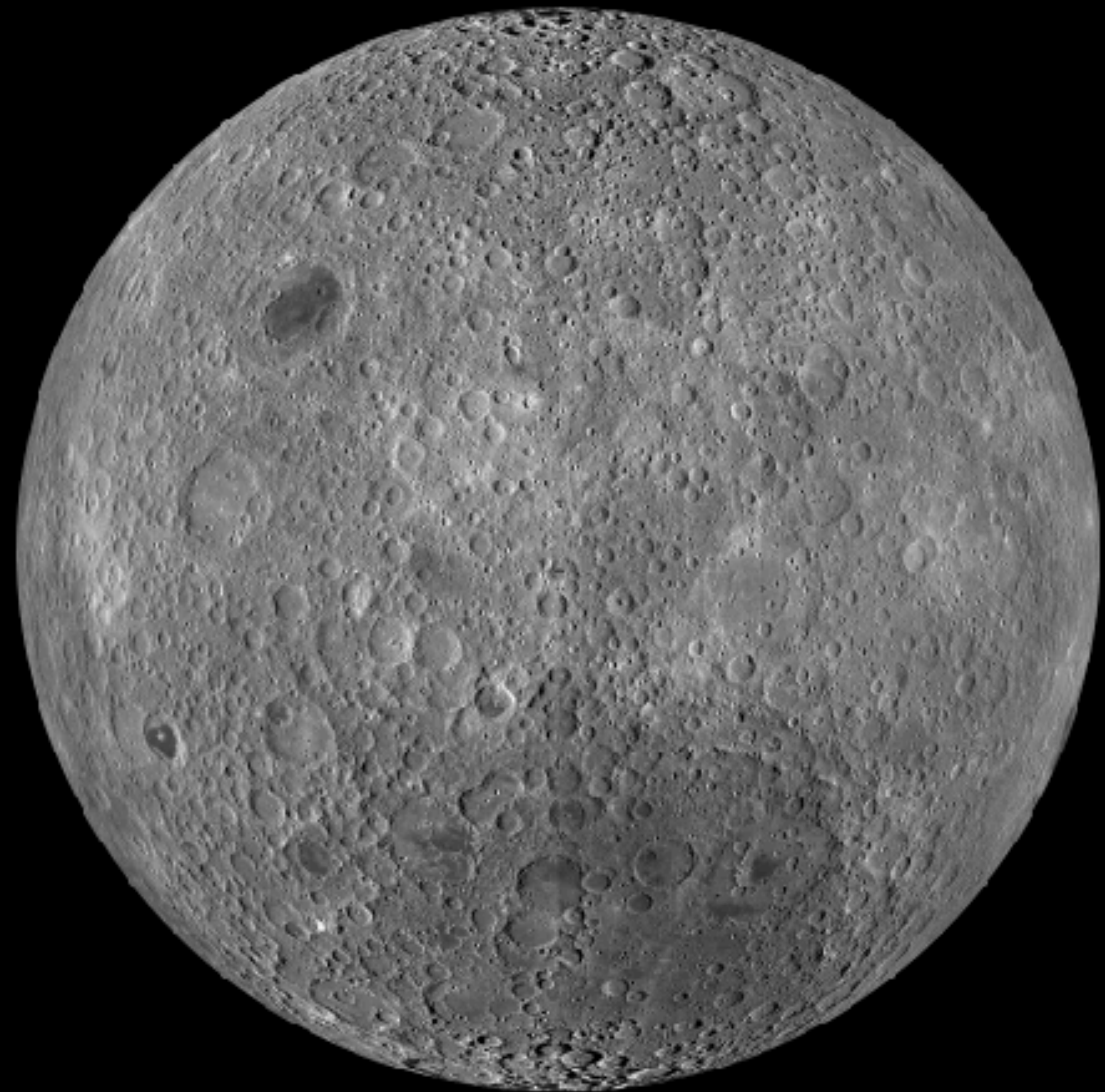
- The name of our moon is Luna. It is about  $1/80$  the mass of the Earth and  $1/6$  the surface gravity.
- The low surface gravity means the Moon can't retain an atmosphere; gasses are able to escape its gravitational pull. This is an important similarity with Mercury.
- The Moon has a density of  $3.3 \text{ g/cm}^3$ , much less than the Earth or Mercury. This density implies the Moon is almost entirely rock with little, if any, metallic core in its center.
- The Moon has been explored by people and samples of Moon rock taken back to Earth. Thus we know more about the moon than any planet aside from Earth.

# Earth's Moon

maria



Near Side



Far Side

# The Lunar Surface

- The most obvious lunar surface feature are the maria which can be seen without a telescope. They are named mare because to early astronomers they looked like seas. But they are actually lava flows that leave behind flat black igneous rock.
- The other main surface feature is that the Moon is heavily cratered. These are the results of meteor impacts that on the Moon never get erased.
- The rocks brought back from the Moon have been found to have ages between 3.6 and 4.4 billion years old.

The maria are younger less cratered rock. They are similar to the rock under the ocean on Earth. While younger they are at least 3.3 billion years old. They are only found on the near side of the Moon.





The rest of the Moon's surface is called the lunar highlands. They are heavily cratered and very old, 4.1 to 4.4 billion years ago.

Unlike mountains on Earth, these don't have sharp ridges, but are rounded. This is because there is no erosion on the Moon, so cliffs, valleys, dunes, etc. don't form.







The lunar surface is covered in fine dust. This dust is not the result of wind erosion, but of meteor impacts. After billions of years of impacts almost all of the surface is covered in this dust.

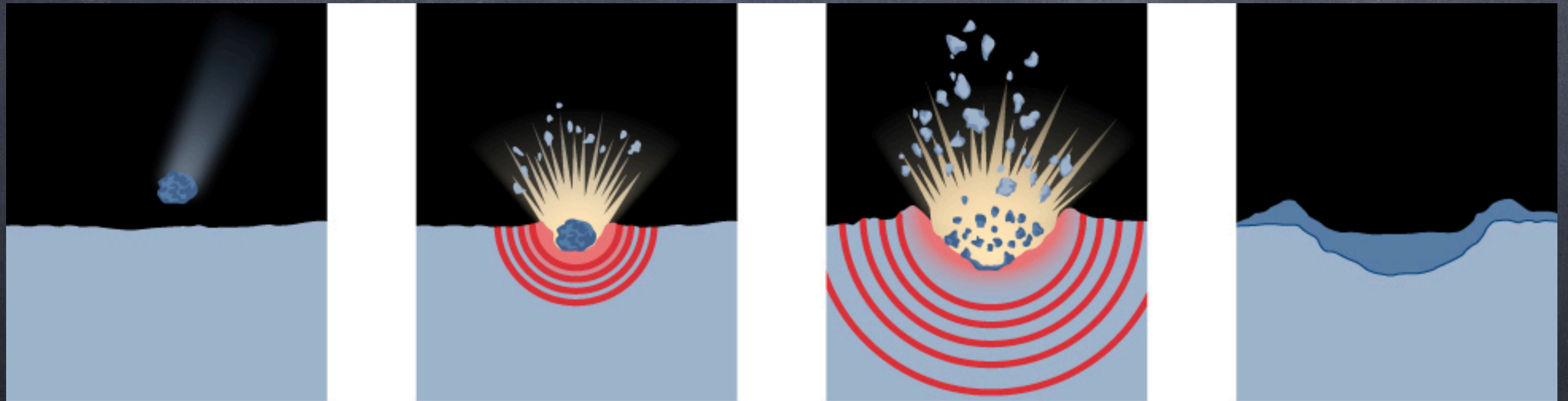
There is also water on the Moon, but it is frozen in deep chasms. There is no water on most of the surface which is why the dust stays dust and doesn't become mud.

<https://www.youtube.com/watch?v=mIRPeYGKfi>

# Temperature on the Moon

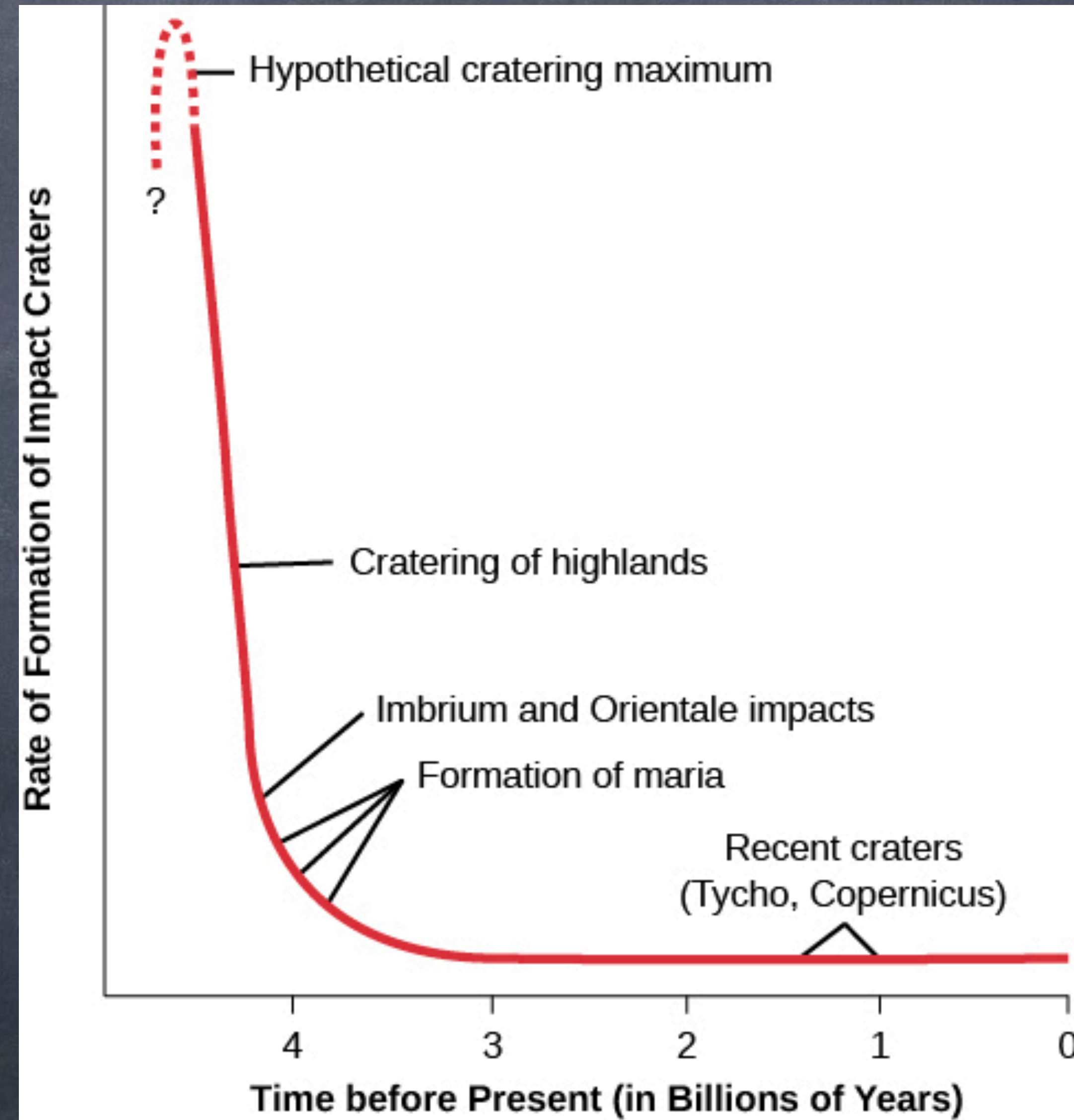
- The temperature on the Moon ranges from  $100^{\circ}\text{C}$  to  $-170^{\circ}\text{C}$ , that's more than  $250^{\circ}\text{C}$  difference.
- This occurs because the Moon lacks an atmosphere and rotates slowly.
- On the Earth heat is transported by the air from hot places to colder places and noon only lasts a few hours and then night begins a few hours later.
- On the Moon there is no transport of heat from the equator to the poles and the 27.3 day rotation period means noon lasts many days and night last 13 days. Thus the rock heats up high and cools down to very low values.

Impact craters are the dominant surface feature on the Moon. Meteors hit the moon at 10km/s or faster. At these speeds it will penetrate the surface 2 to 3 times its diameter before stopping. Shockwaves vaporize the meteor and some of the surrounding material. A crater 10 times that of the impactor is created. Ejecta fall around the crater and often create secondary craters as they fall back to the surface.



# Counting Craters

- The number of craters on a surface tell us about its age, the more craters the older the surface.
- The rate of bombardment has been pretty constant for a long time, but was much higher just after the solar system formed.
- We will use this information to date the surfaces of all other objects in the solar system.

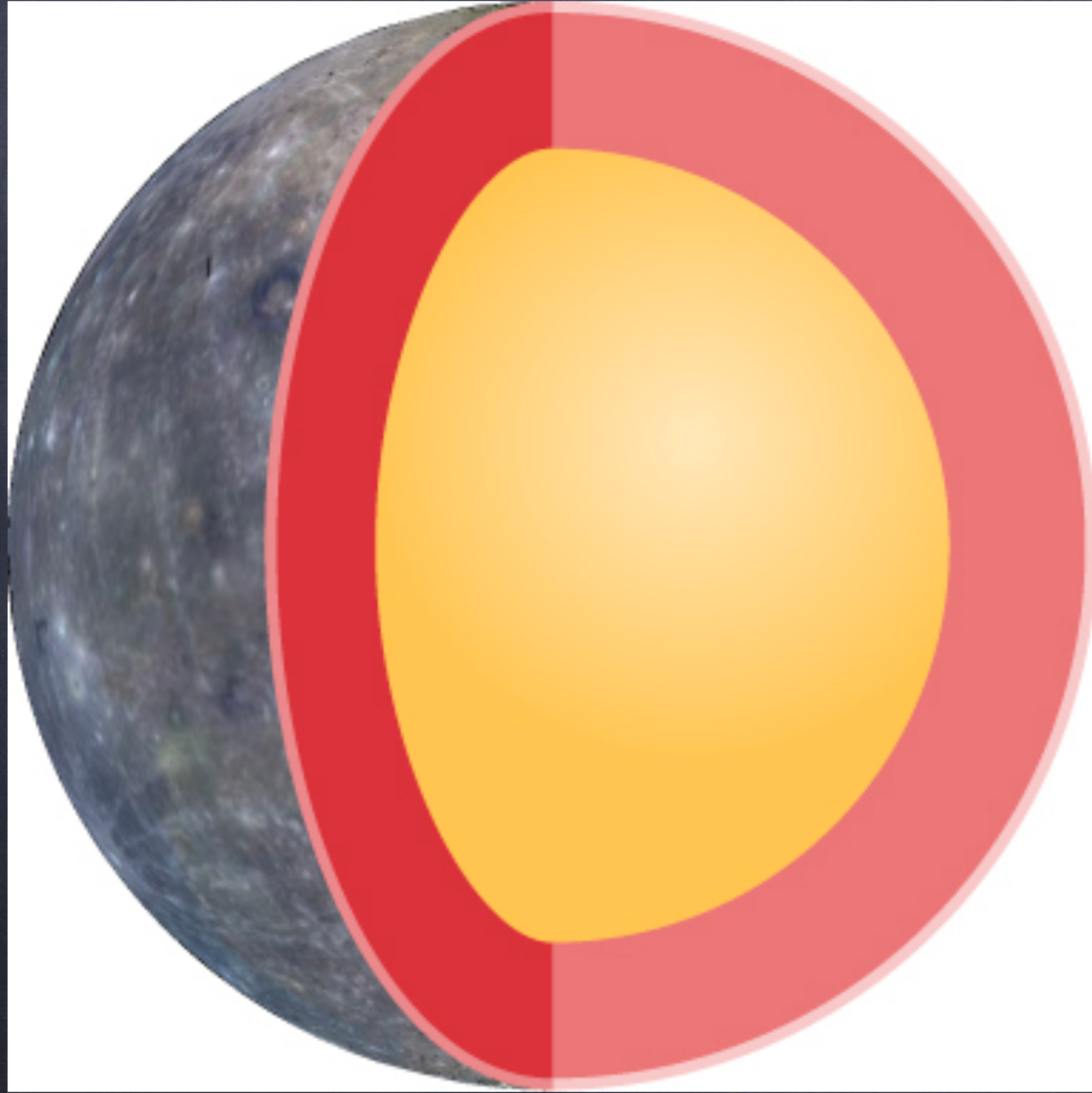


# Origin of the Moon

- There are many theories for the origin of the Moon but today most scientist think it is the result of a giant impact with the forming Earth.
- This impact would have stripped off part of the outside of Earth, and thus only rock no metal.
- Then this stripped material would form a ring and eventually come together as the Moon.
- This theory explains why the Moon is all rock and little metal. And why the Moon is so close to the Earth in mass.

# Mercury

- Mercury is in many ways similar to the Luna, it has no atmosphere and it is heavily cratered.
- It can be hard to see in the sky because it is so close to the Sun. It is only visible about 1.5 hours after sunset or before sunrise.
- As the closest planet to the Sun (0.39AU) it has the shortest year, orbiting the Sun in only 88 Earth days.
- Its mass is only  $1/18$  of Earth's mass or 4.5 times Luna's mass. Its radius is half of Earth's, but its density is  $5.4 \text{ g/cm}^3$ , similar to the Earth's.



That Mercury has a higher density than Earth means Mercury's core is even bigger than Earth's. The theory to explain this is that like the Earth, Mercury was hit by large objects during its formation which broke off some of the rock on its surface. Unlike the Earth, that material didn't form a moon possibly because Mercury is so much closer to the Sun.

Mercury also has a weak magnetic field. This means part of the core must be liquid.

# Mercury's Strange Rotation

- Mercury has a strange orbit around the Sun. It takes 88 Earth days to go around the Sun and rotates around its axis in 59 Earth days.
- Thus 2 Mercury years is equal to 3 Mercury days. This is similar to the Moon's 1:1 ratio between its revolution and rotation, but instead is 2:3.
- It turns out Mercury is phase locked with the Sun, but in a more complicated pattern because it has an eccentric orbit.



# Mercury's Temperature

- Mercury has the greatest change in temperature on its surface because it has no atmosphere and rotates very slowly.
- Mercury's daytime temperature can reach 700K (430C) while the night time temperature can go as low as 100K (-170C).
- That's a change of 600 degrees. Of course that change could take 45 Earth days to occur.

# Mercury's Surface

- Mercury's surface much like the Moon is heavily cratered. There are thousands of craters and some are as big as 1300km in diameter.
- Mercury also has an unusual feature called a scarp. These are cliffs as much as 1km high and 100s of km long. They cut across craters so they must be younger than those craters. It is believed that these are the results of Mercury shrinking like fruit that has dried and shrivels up.

