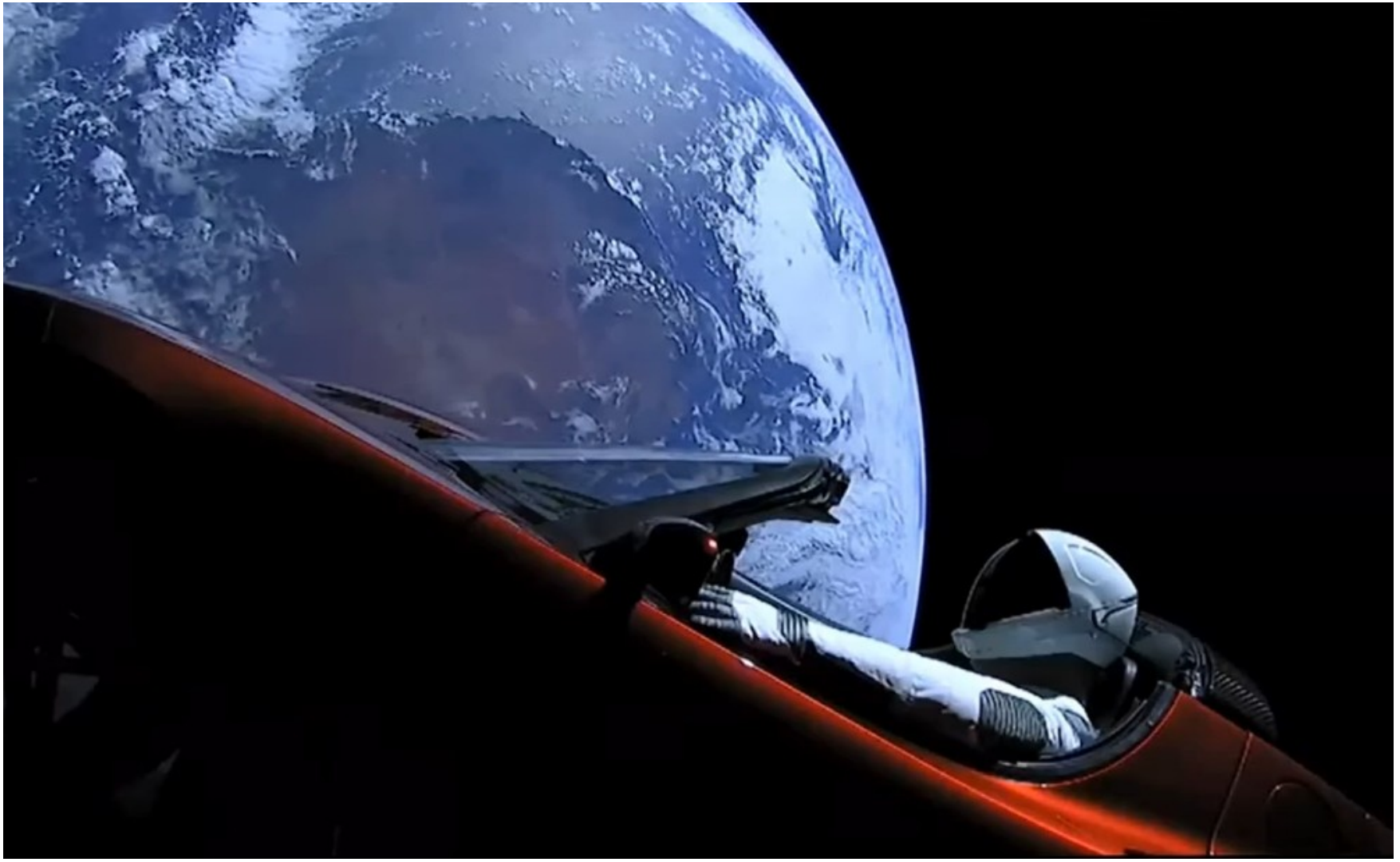
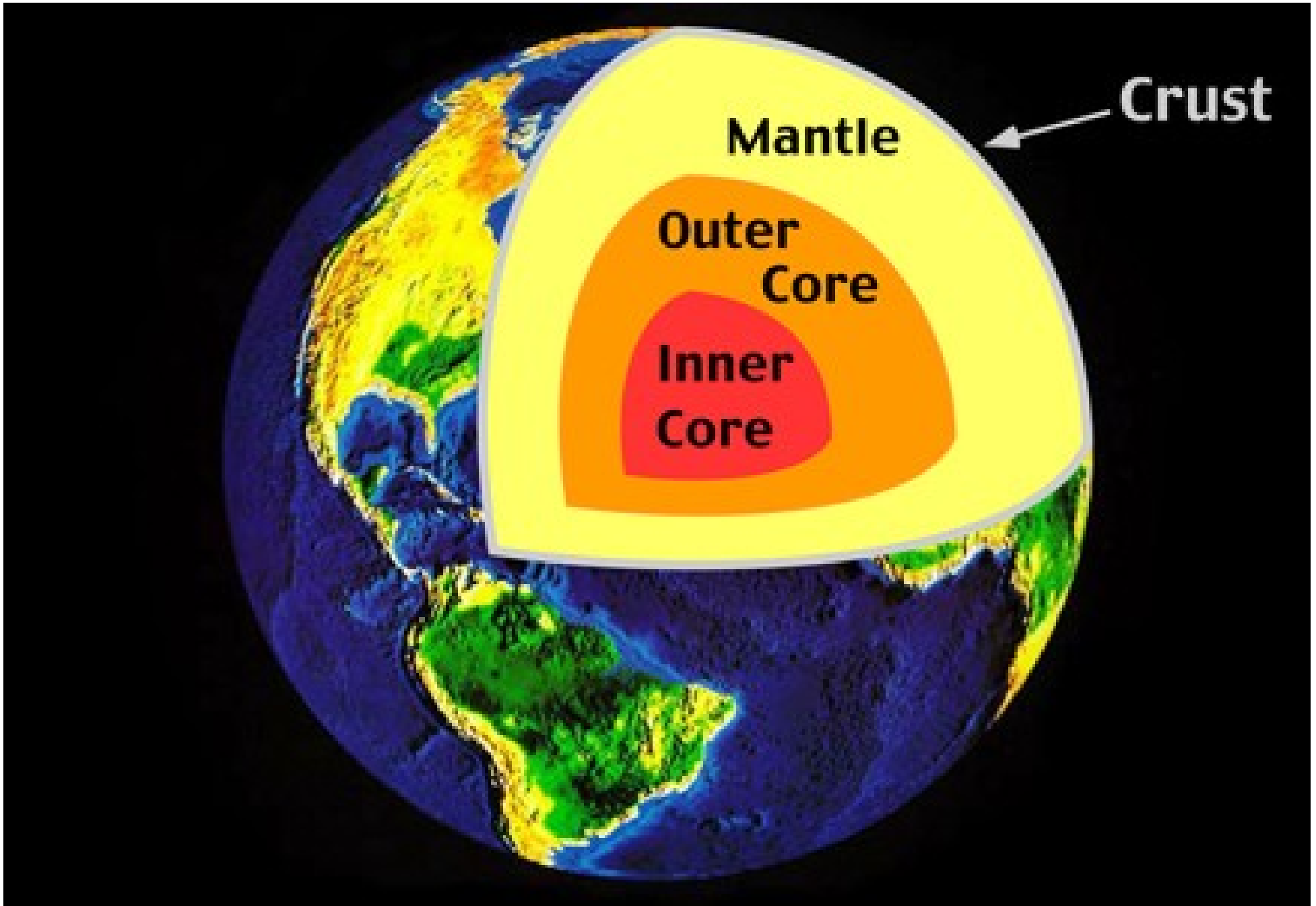
“I always wanted to be somebody, but I should have been more specific.” Lilly Tomlin

Reading has been updated.HW1 is on the web page now and due next Monday at the beginning of class.

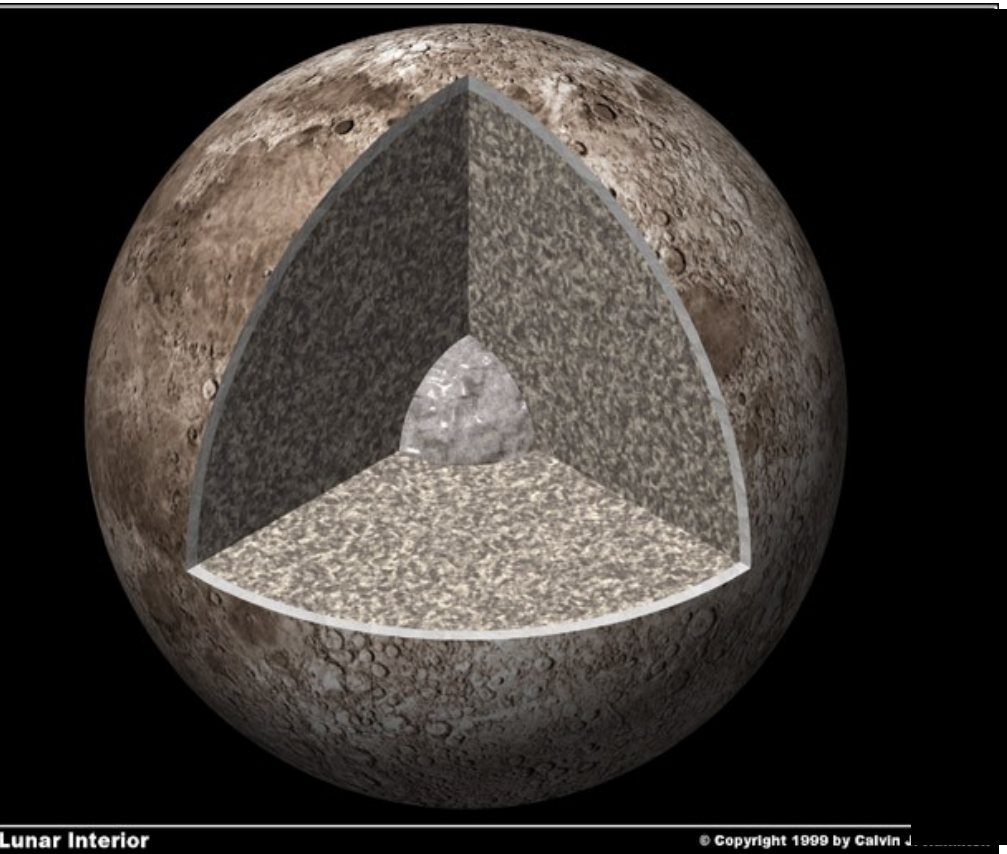


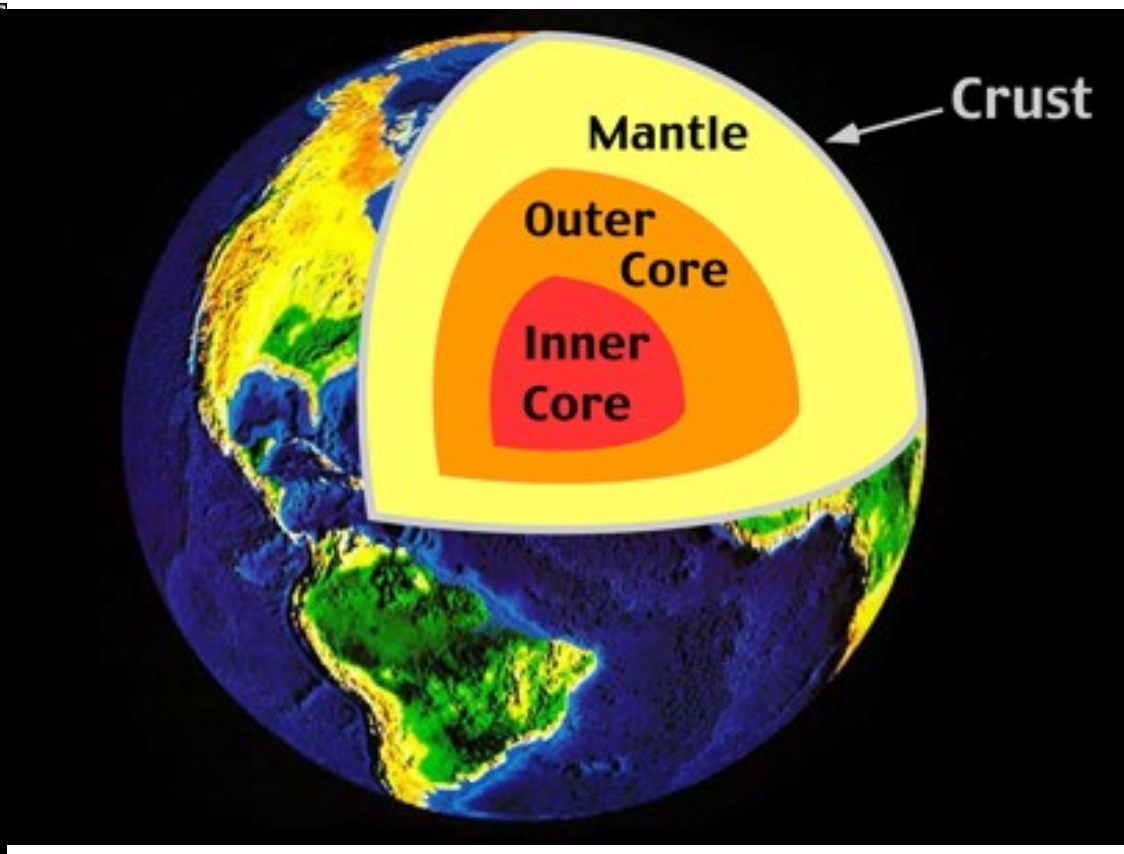
The Earth's structure: Density=5.5g/cc



Structure #1(we will have 5)

Thin atmosphere over
Rocky crust over
Rocky mantle over
Rocky core.





How does a planet get a moon?

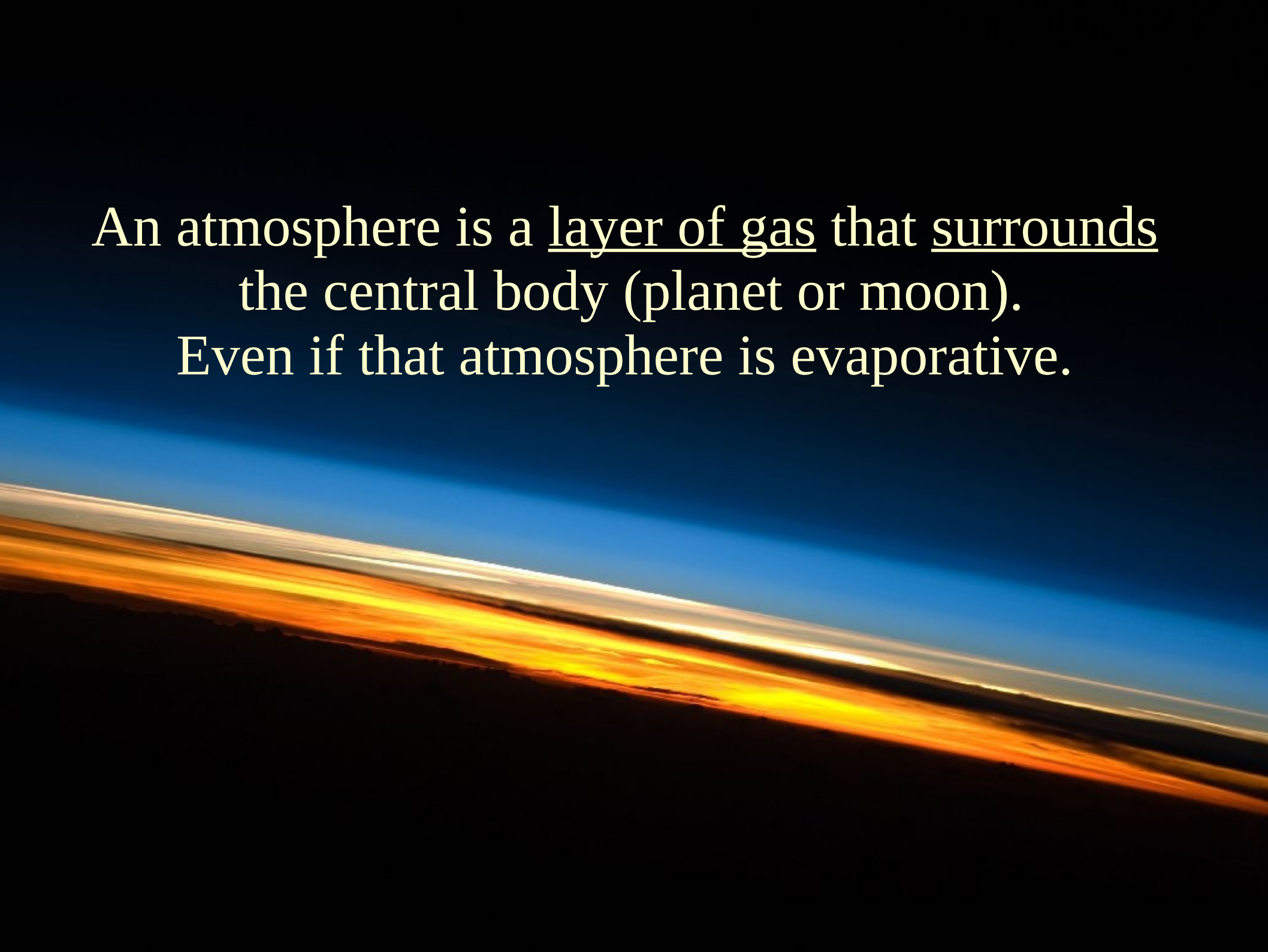
- It forms along with the planet:
- Captured:
- Split from planet:
- Formed from a ring of material that was made by a giant collision.

How do we distinguish between each of these?

Composition and Orbit

Atmosphere

How do you define an atmosphere?

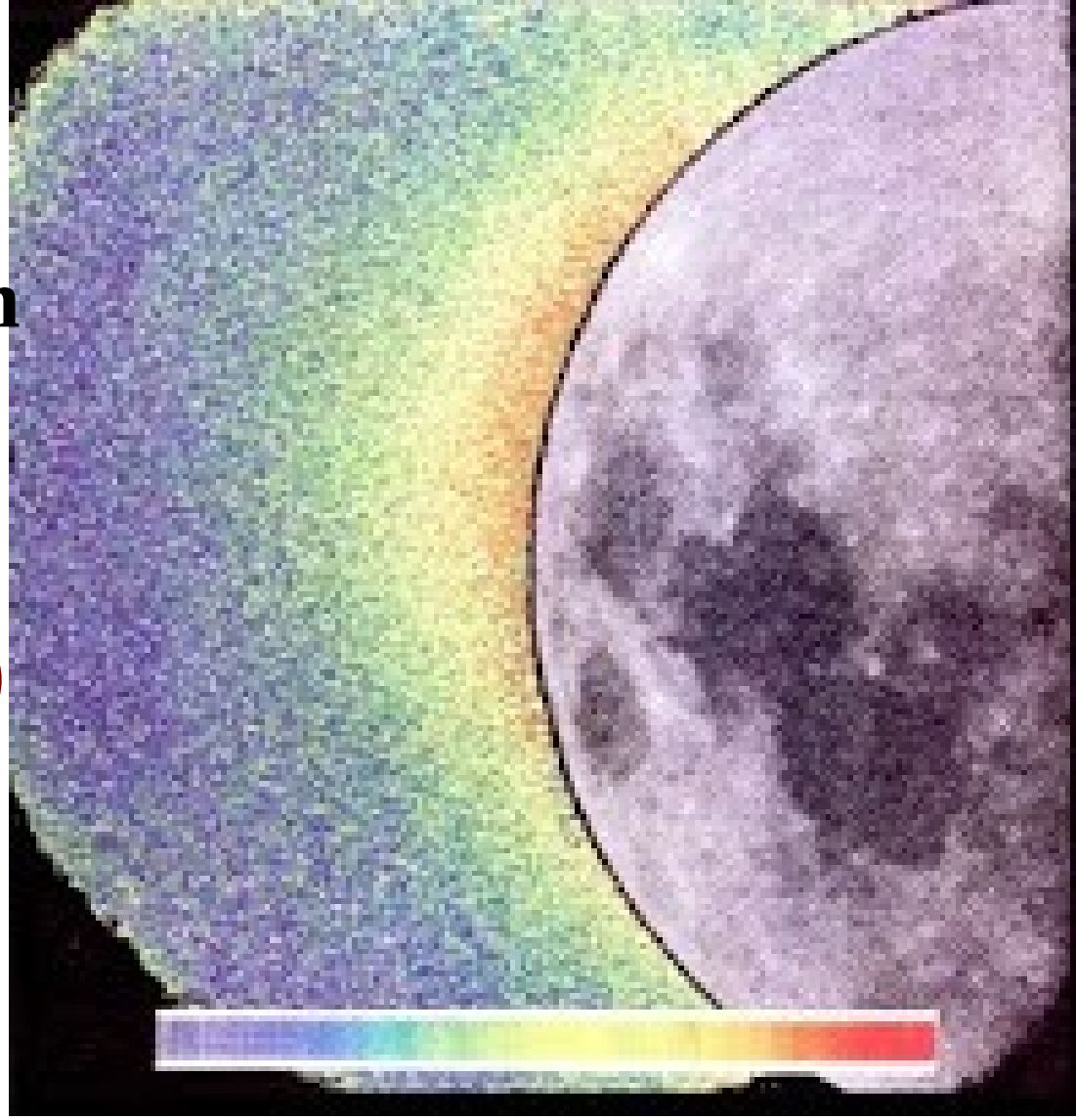

An atmosphere is a layer of gas that surrounds
the central body (planet or moon).
Even if that atmosphere is evaporative.

By this definition, our Moon has an atmosphere.

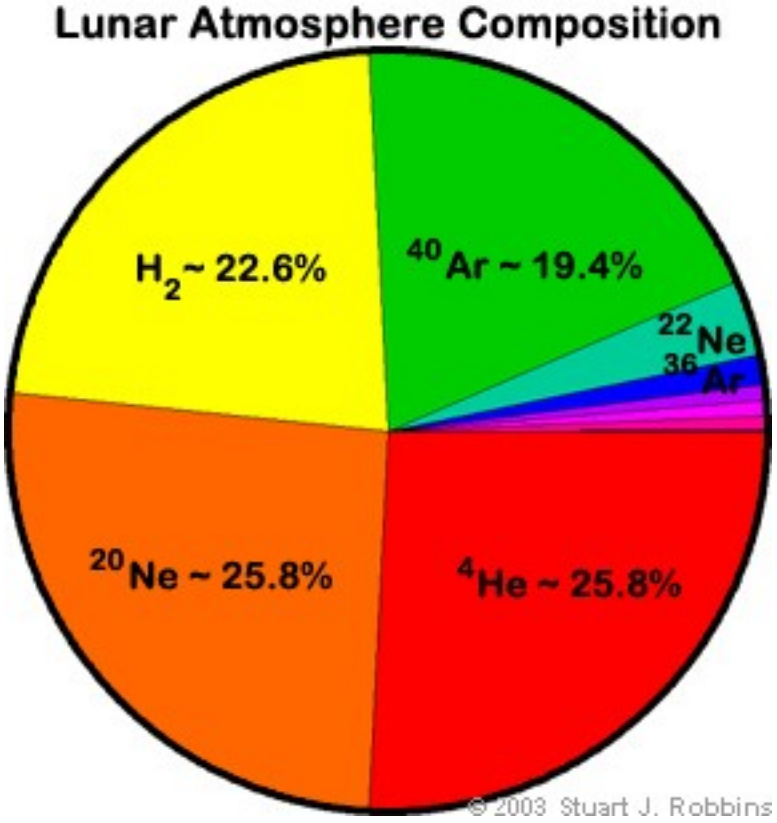
A somewhat controversial conclusion.

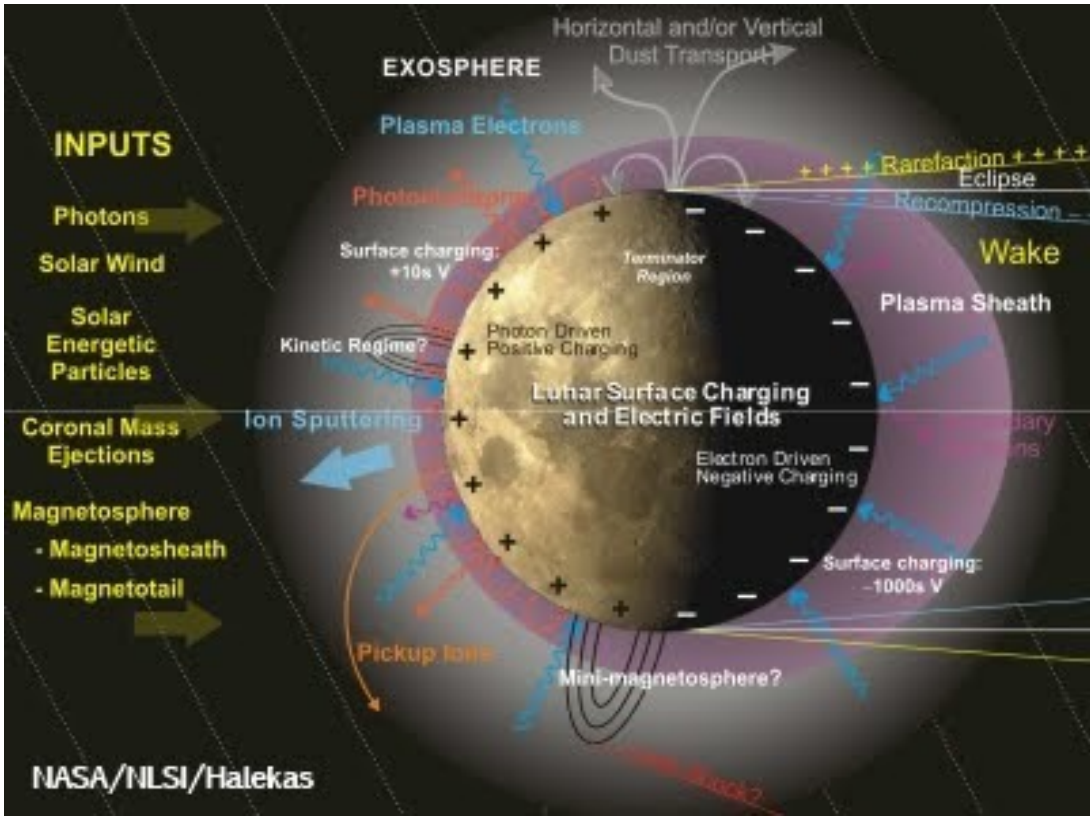
Textbook says, “(gravity is) too low to retain an atmosphere.”

The Moon’s atmosphere is evaporative.



The Moon is pelted by protons and electrons from the Sun's solar wind. These particles free other particles from the Moon's soil. Along with radioactive decay, this produces a thin atmosphere (mostly neon, helium, hydrogen and other stuff).



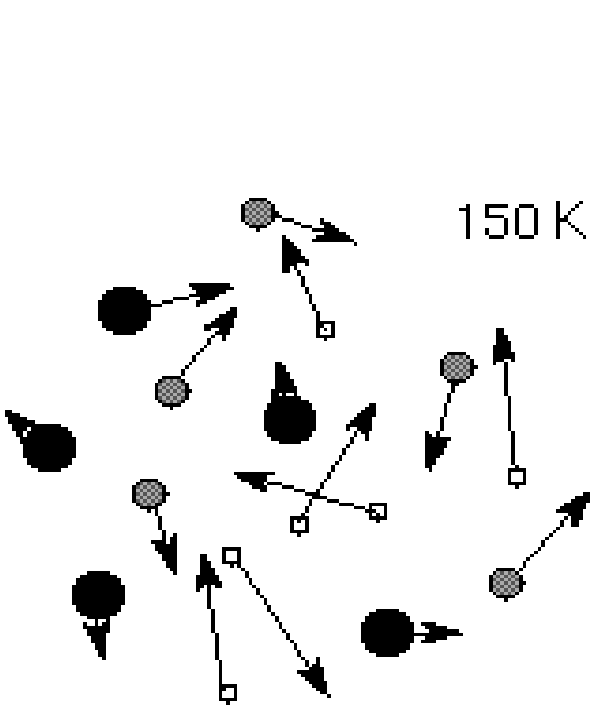


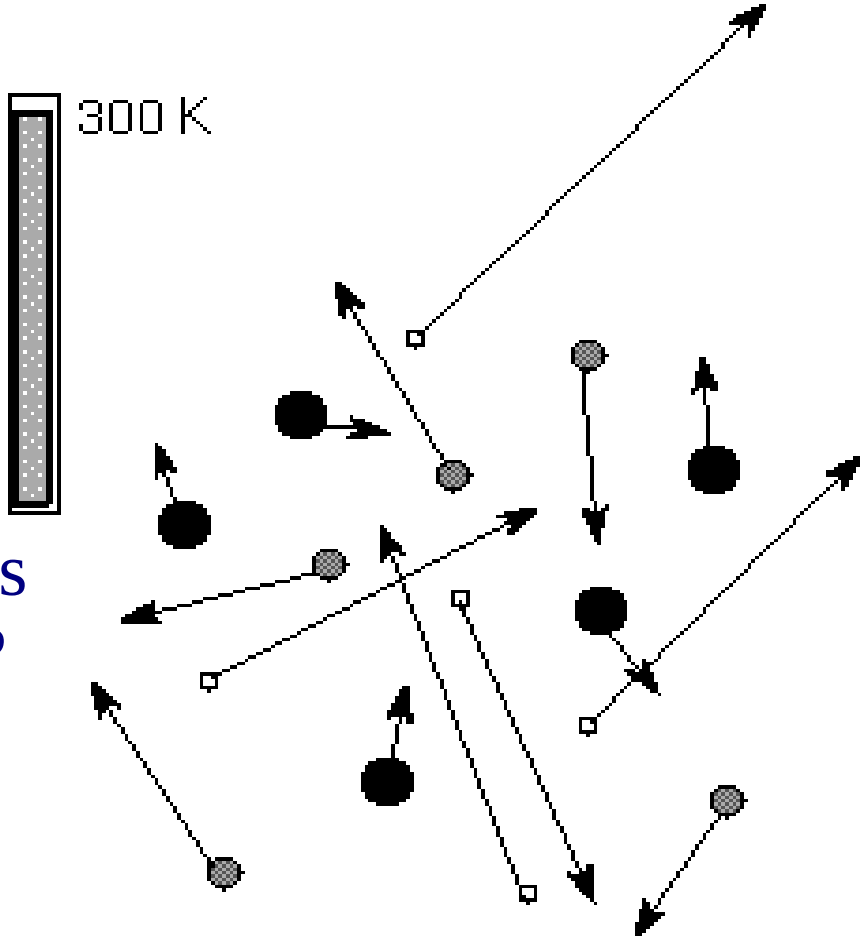
light gas (H_2 or He)

"medium" gas (N_2 or CH_4)

heavy gas (CO_2)

Temperature: measure of average kinetic energy of molecules.





What determines an atmosphere?

Lower Temperature:
- slower ***average*** speeds
- heavy gas molecules move slower than lighter gas molecules

Higher Temperature:
- faster ***average*** speeds
- heavy gas molecules move slower than lighter gas molecules

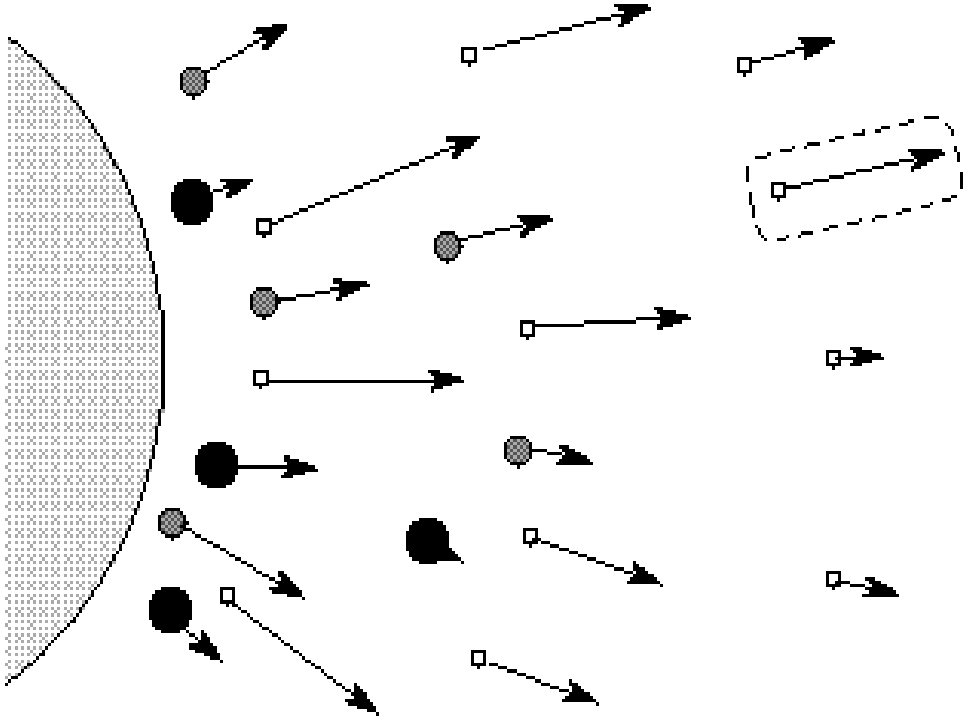
$$v_{gas} = \sqrt{\frac{3 \cdot k \cdot T}{m_{gas}}}$$

If the particles of atmosphere move fast enough, they escape into space. This is determined by:

1) mass of planet (more massive planets have more gravity)

2) mass of gas particles (larger particles travel slower)

3) temperature (determines how fast particles move)



lighter molecules move faster on average so can get higher on average than heavier molecules. Lighter molecules high up more likely to escape planet or moon.

For a hot object (planet/moon) to have an atmosphere, the atmosphere must be a heavy gas or the planet must be massive (high gravity).

For a small object to have an atmosphere, the atmosphere must be a heavy gas, or the planet must be cold.

For an object to have an atmosphere made of light gases, the planet must be massive, or very cold.

It is easier to make large molecules when temperatures are cold.

The amazing planet EPIC 228813918b orbits its star every 4.3 hours. It is an Earth-massed planet and likely 52% iron with a silicate mantle. If this planet has an atmosphere, it must be:

A) very cold to keep an atmosphere.
B) extremely massive gas particles.
C) extremely light gas particles.
D) very hot to keep an atmosphere.

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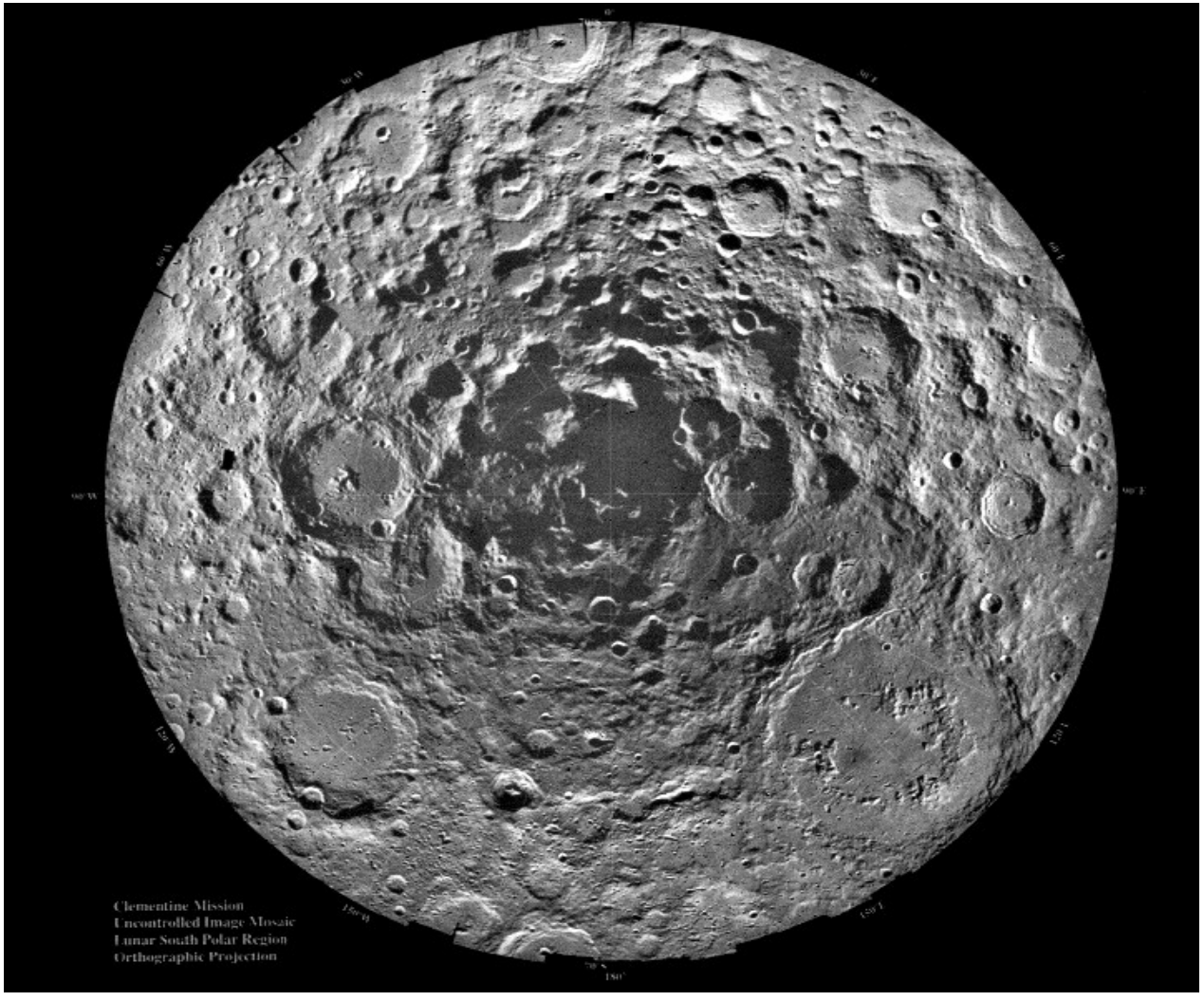
The Earth-Moon system is *dynamic*. It seems like it is constant, but it is always changing.

Similarly, our solar system seems like the same ol' thing. But in fact it is in the process of changing all the time!!!!

Water on the Moon?

There are areas on the Moon that never receive direct sunlight. **IF** ice can get in there, it will not evaporate.

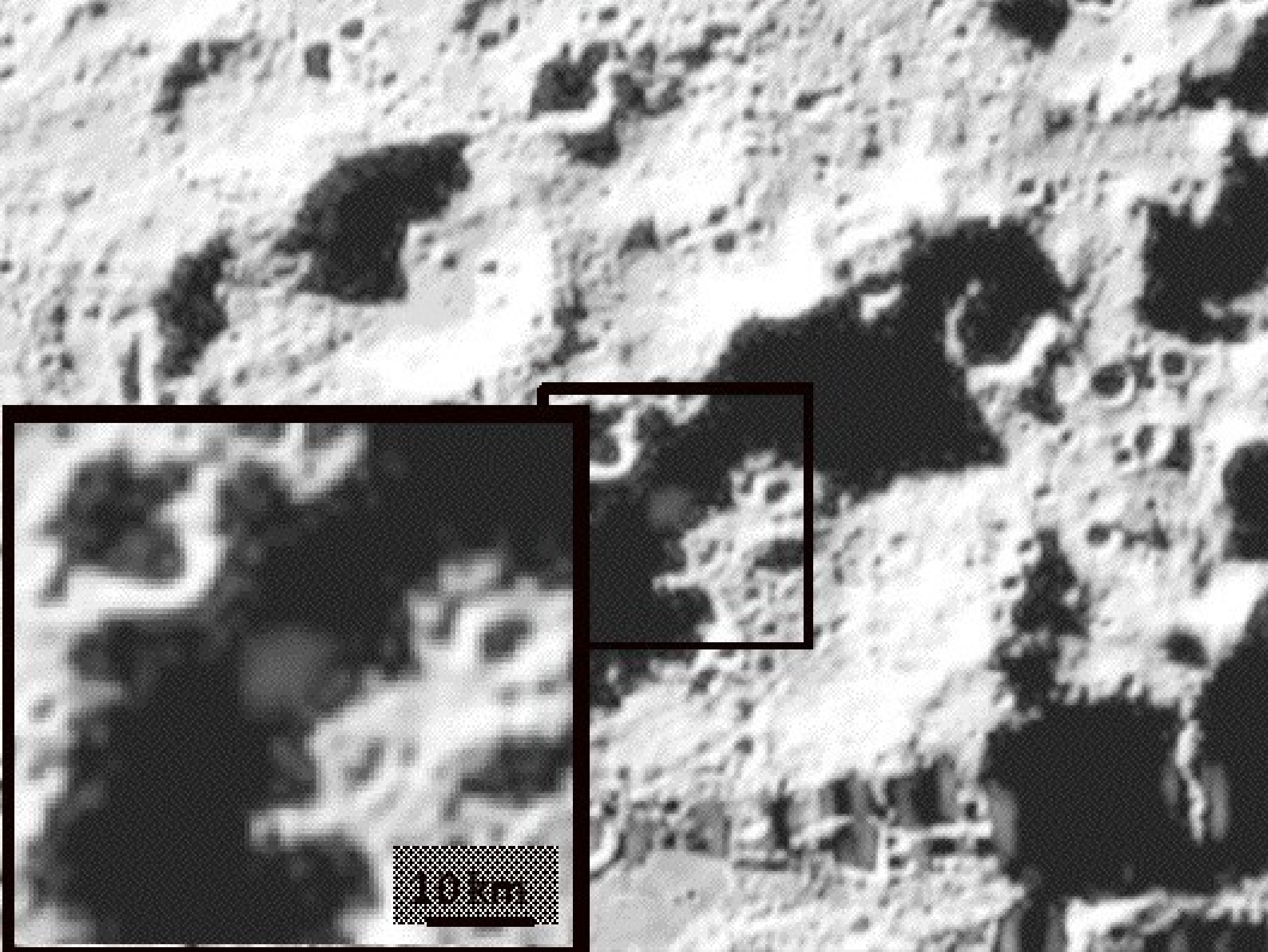


Eureka!

Experiments on several satellites detected the signature of water on both the North and South Poles of the Moon.

Each pole possibly contains at least a small-ish lake's worth of water-ice.

L-Cross impacted into this icy soil in 2010.


10 km

Where did all that water come from?
Possibly from comets in the early solar system

Which of the following statements is true?

A) The Earth and Moon are the same as they have always been. Nothing changes with time on their surfaces or between them.

B) The Earth and Moon are always changing, especially the Earth's surface and orbit/spin between the Earth and Moon.

C) The Earth and Moon orbit/spin is changing, but the surfaces of both objects has never changed.

D) Only the Earth's surface is changing with time, nothing else.

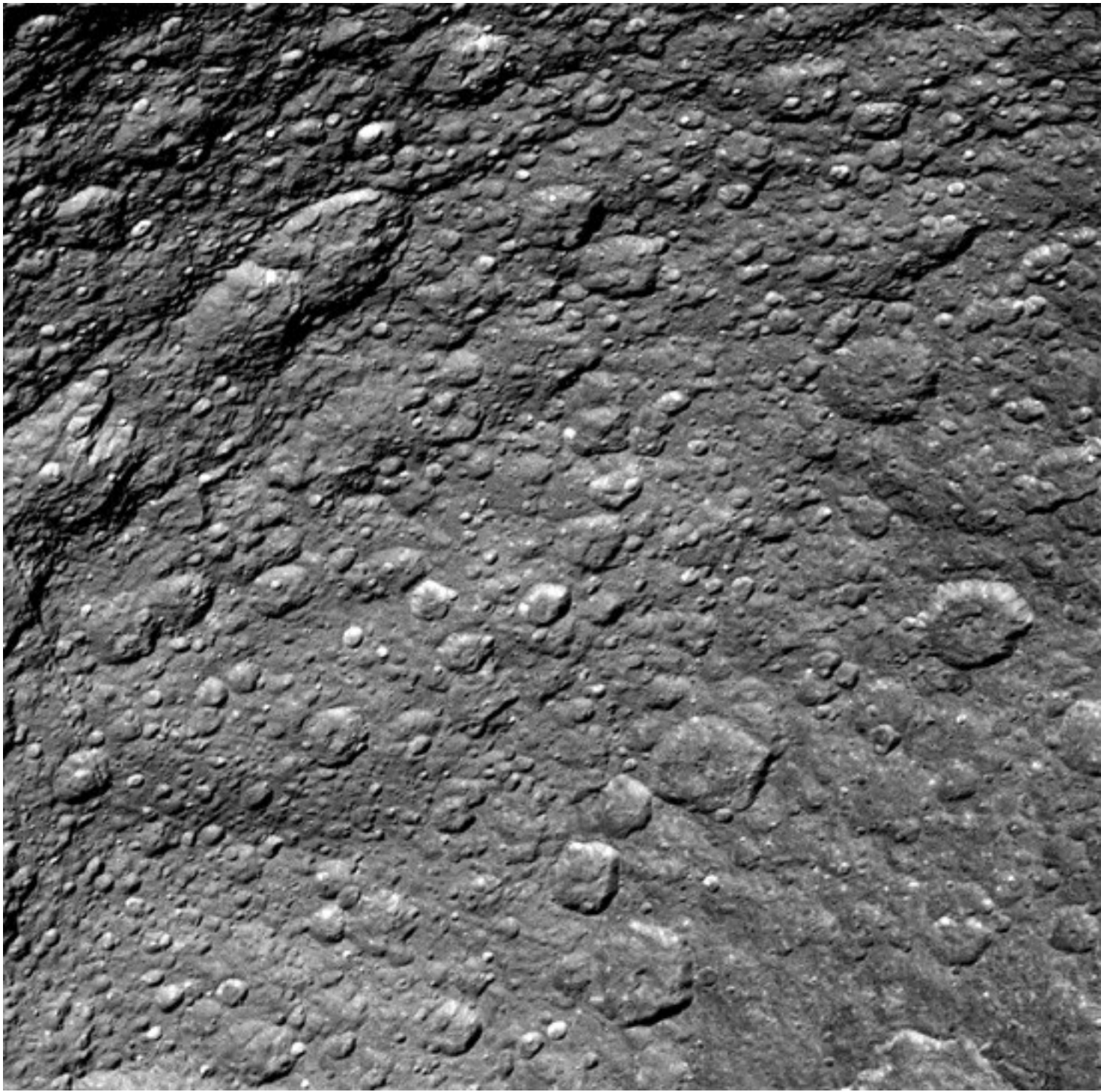
Review of what we've learned from the Earth-Moon system.

Surface age based on cratering

1) Smothered with craters; the surface is 4+ billion years old. (e.g. Lunar Highlands)
2) medium (-heavy?) cratered; 3.5 billion years old. (e.g. Lunar maria)
3) lightly cratered; ~200-500 million years old. (e.g. Earth's surface)
4) no craters; <few million years old.

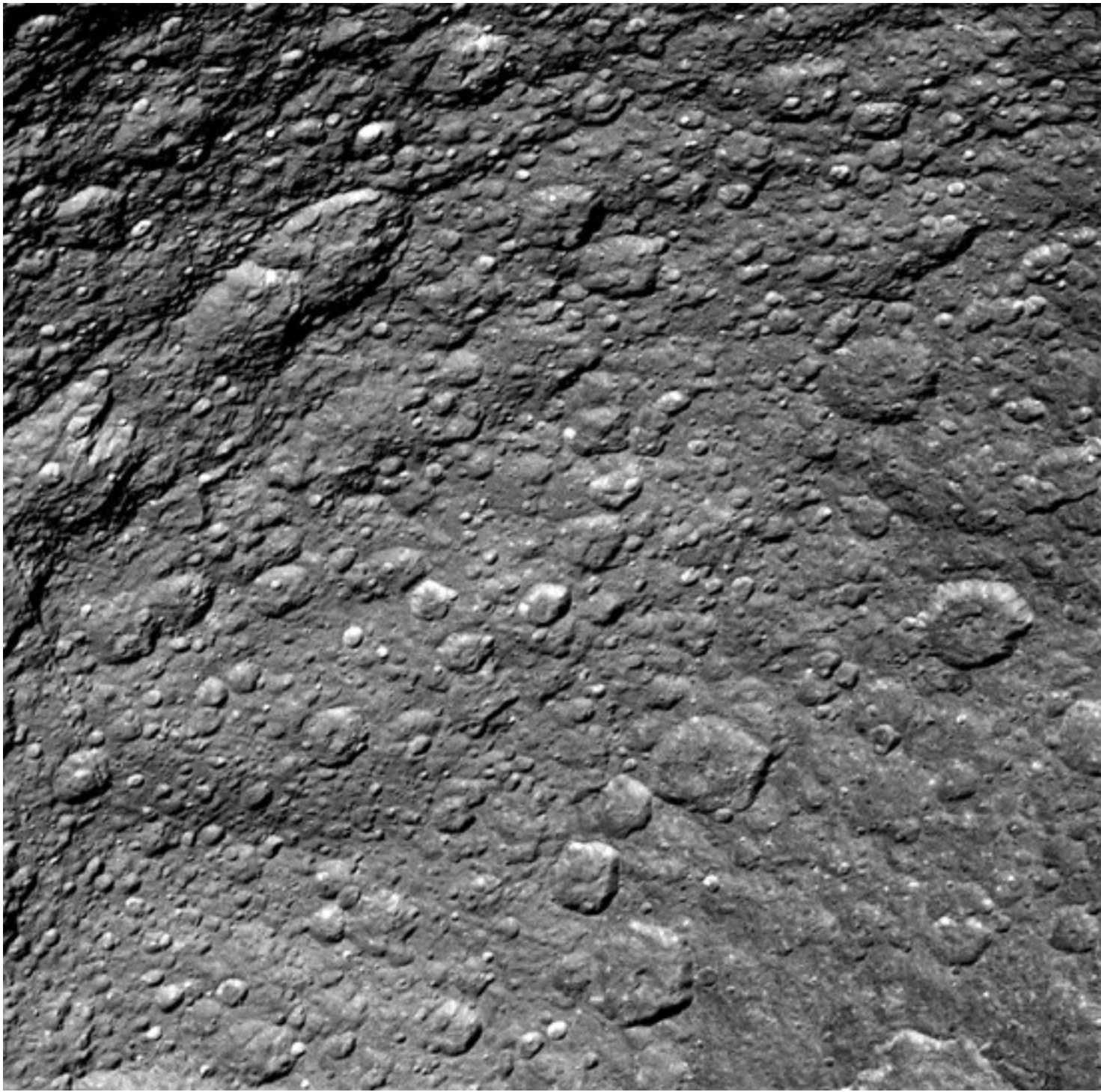
How old is this surface?

A) <few Myrs
B) ~300 Myrs
C) 2 Gyrs
D) 4 Gyrs



How old is this surface?

D) 4 Gyrs



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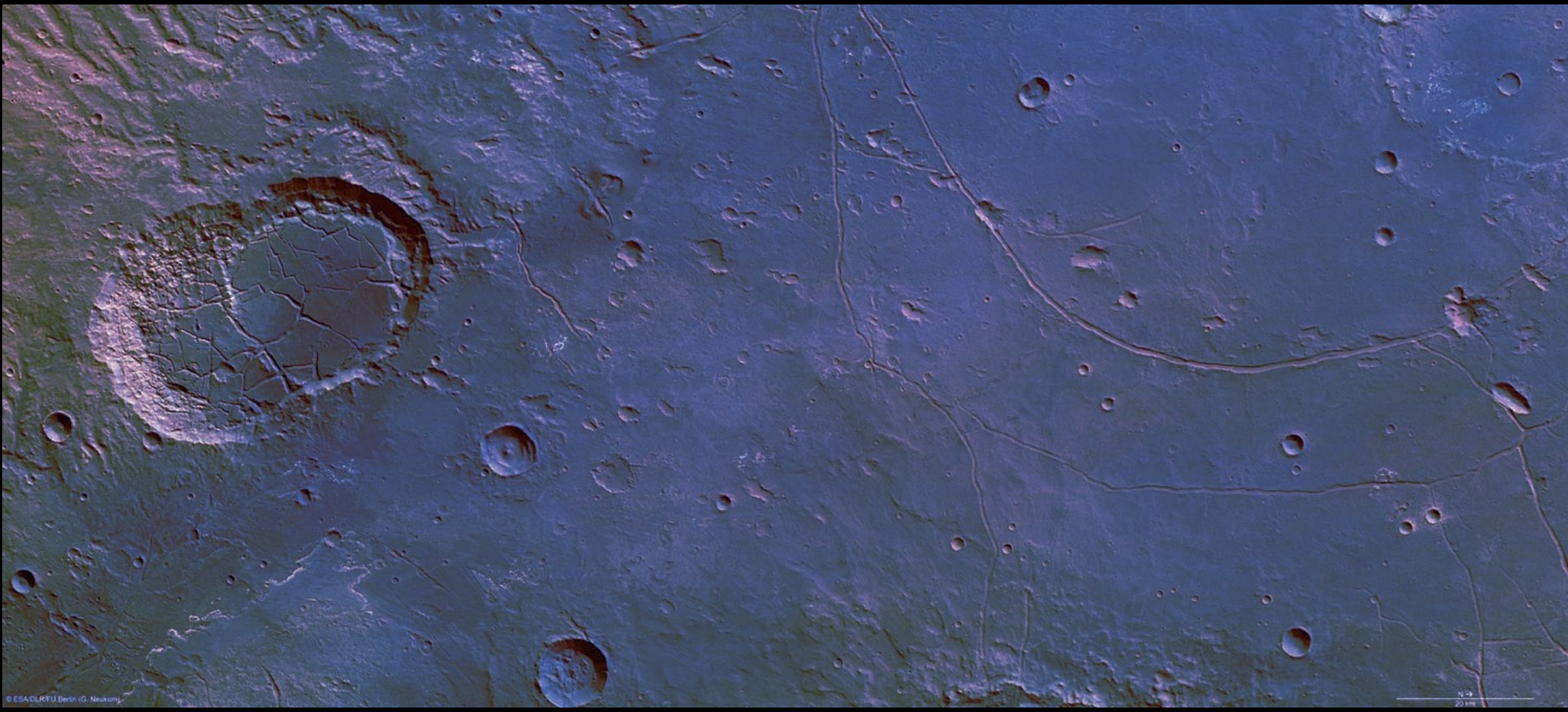
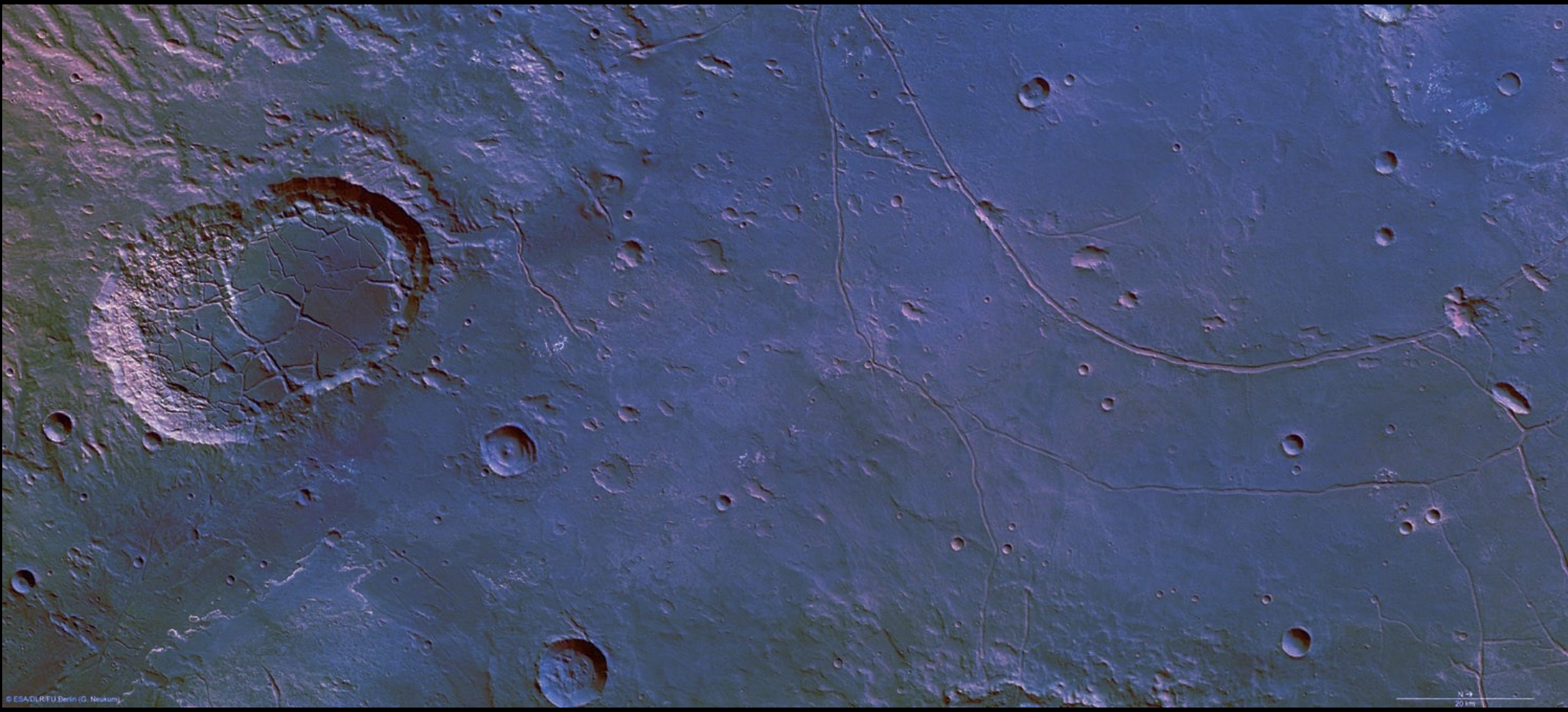


How old is this surface?

C) 2 Gyrs



Surface age based on cratering

If a surface is NOT 4+ Gyrs, there must be a reason for that.

Some form of erosion/resurfacing.

Color Variation

1) Composition (different colors made of different stuff)
2) Temperature (solid, liquid, or gas can change color)
3) Altitude (shading)

Well-defined features usually mean solid.
Hazy features usually mean gas.
Smooth (featureless) usually means liquid.