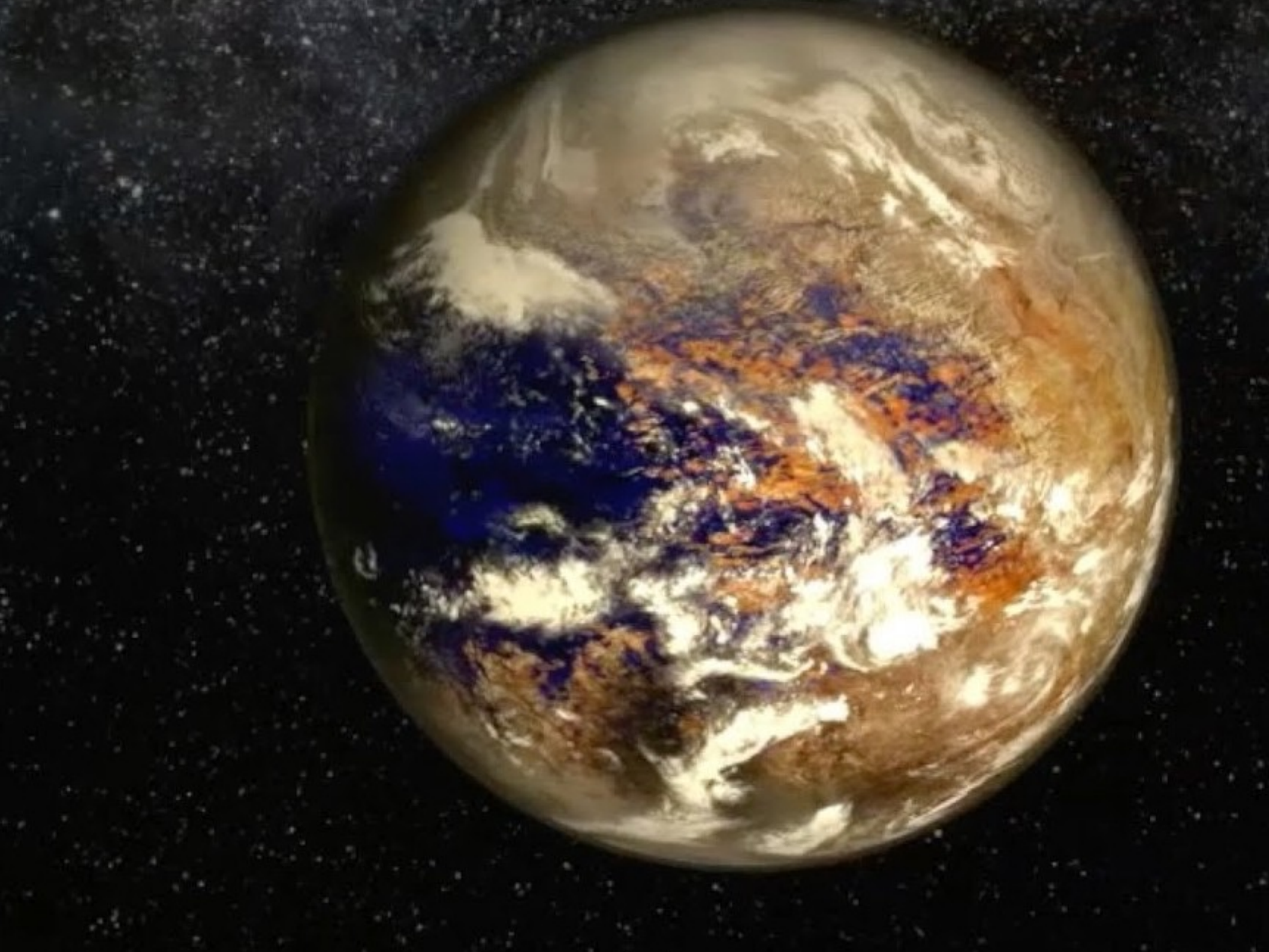
“We demand rigidly defined areas of doubt and uncertainty.”
The Hitchhiker’s Guide to the Galaxy

http://sdbv.missouristate.edu/mreed/CLASS/A115

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

We will do the homework on ‘clickers’ in class on Monday using your written homework as your guide.



Baseline:
The Earth and Moon

From this picture, right down what you see and what it tells us about the Earth

Features we *see* and what they ***tell*** us.

Some Examples

Round- means it is massively big.

Features we *see* and what they ***tell*** us.

Some Examples

Round- means it is massively big.

Features we *see* and what they ***tell*** us.

Some Examples: Is it a solid, liquid, or gas?

well-defined features: solid

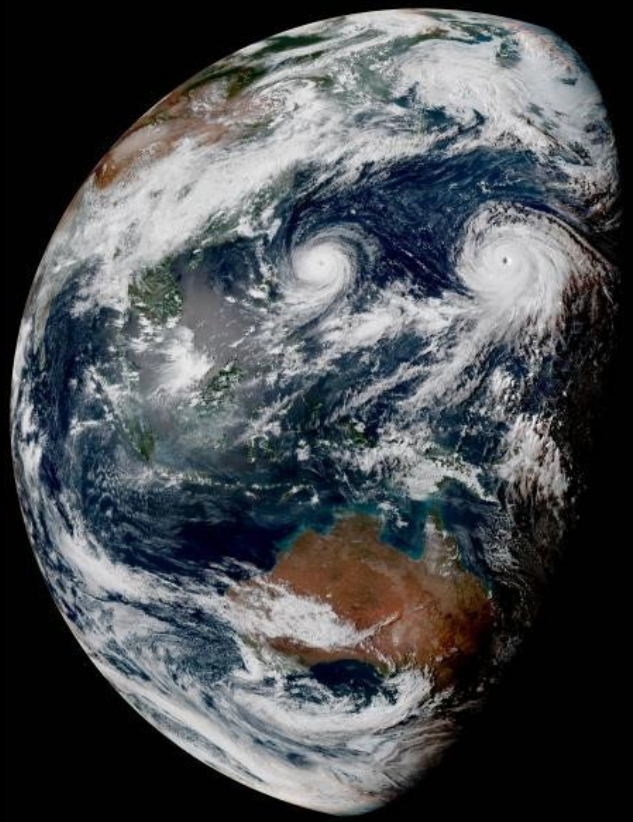
Fuzzy-swirly features, hazy edges: gas: check with multiple images.

Smooth features: liquid

Features we *see* and what they ***tell*** us.

Some Examples: Is it a solid, liquid, or gas?

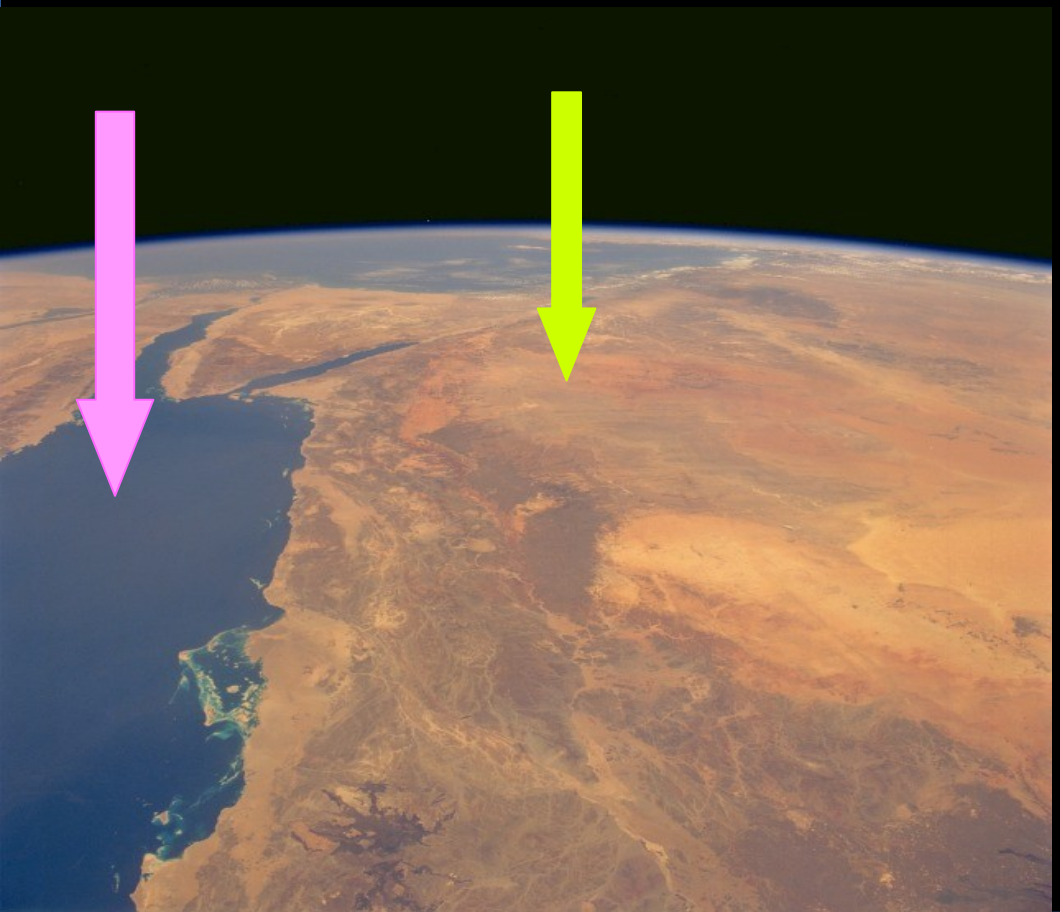
Fuzzy-swirly features: gas: check with multiple images.



Features we *see* and what they ***tell*** us.

Some Examples

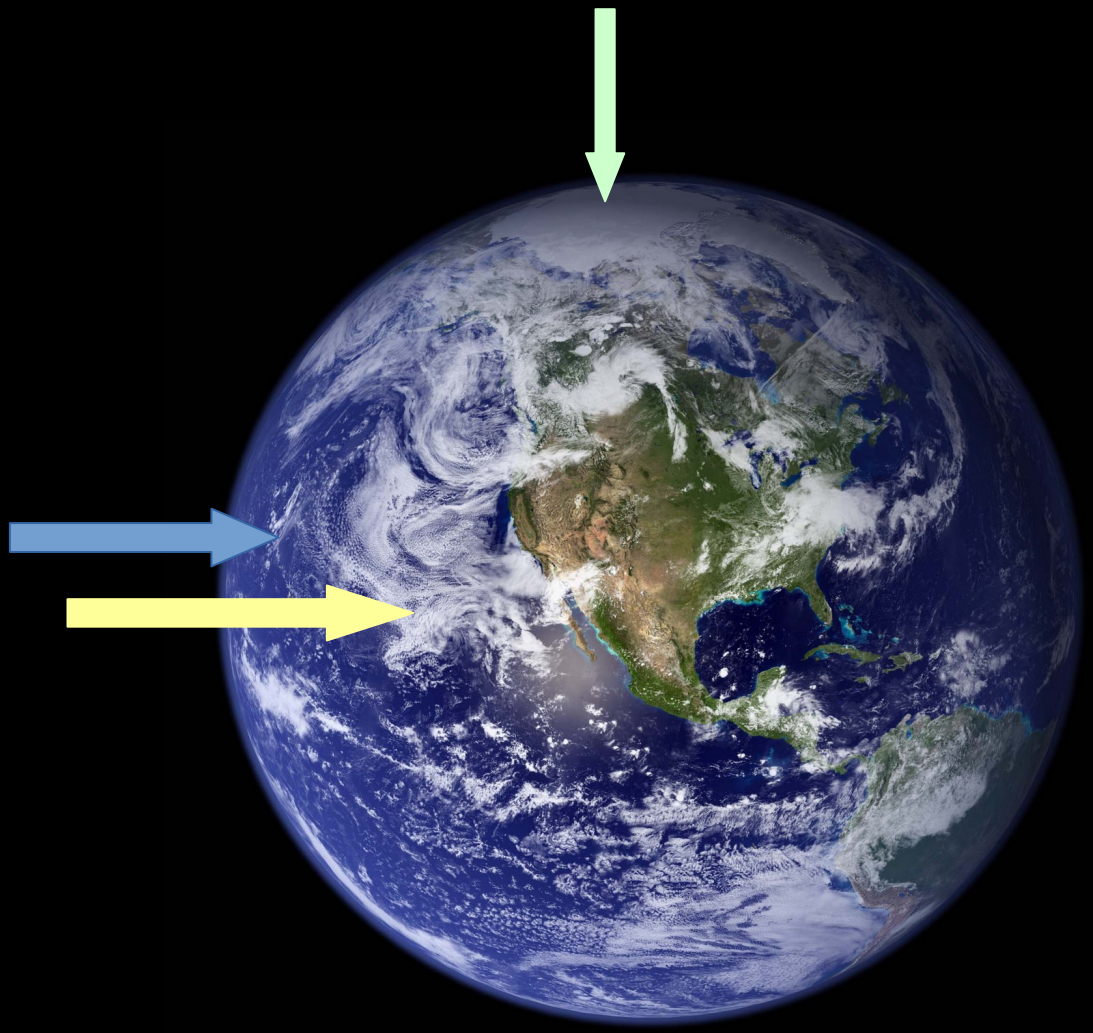
multiple colors- multiple compositions



Features we *see* and what they ***tell*** us.

Some Examples

multiple colors- changes in temperature



Features we *see* and what they ***tell*** us.

Some Examples

multiple colors- changes in altitude, usually as shading.

Features we *see* and what they ***tell*** us.

Some Examples

multiple colors- changes in temperature, composition, and/or altitude. **Choose the best one!**

Let’s look again

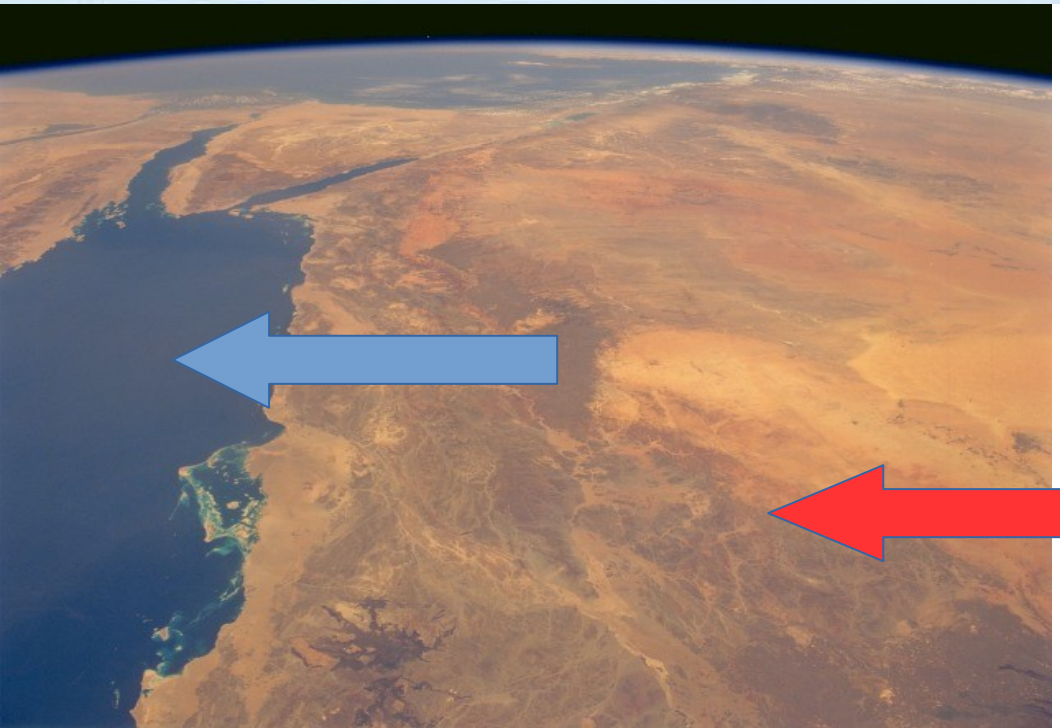
Quiz 1: What is the main difference between the brown and the blue?

A) Composition
B) Temperature
C) Altitude

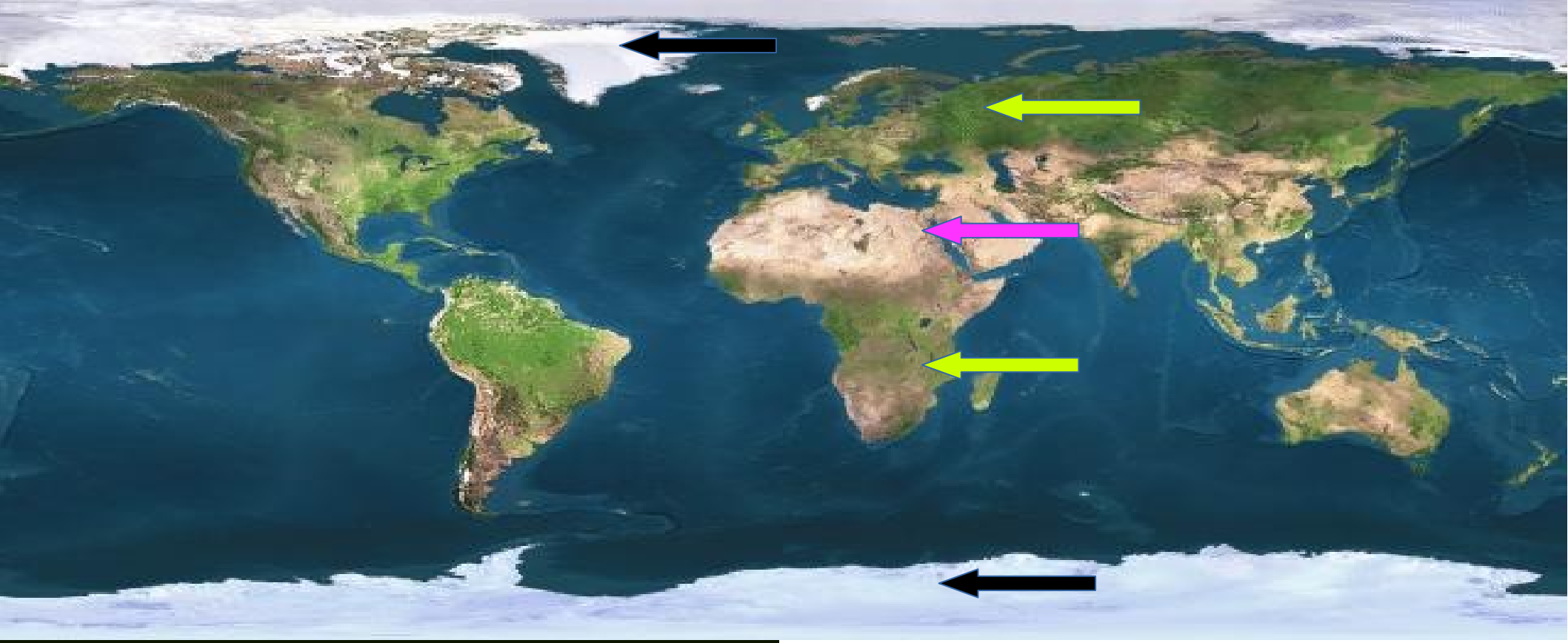
Let’s look again

Well-defined features = solid

Smooth, featureless region = liquid



Two colors, at least two compositions.



‘Zone’s of color from the middle to top/bottom.

A couple of other landforms and what they tell us.

Mountain ranges (not single mountains), indicate plate tectonics.

Earth’s plates indicate internal structure

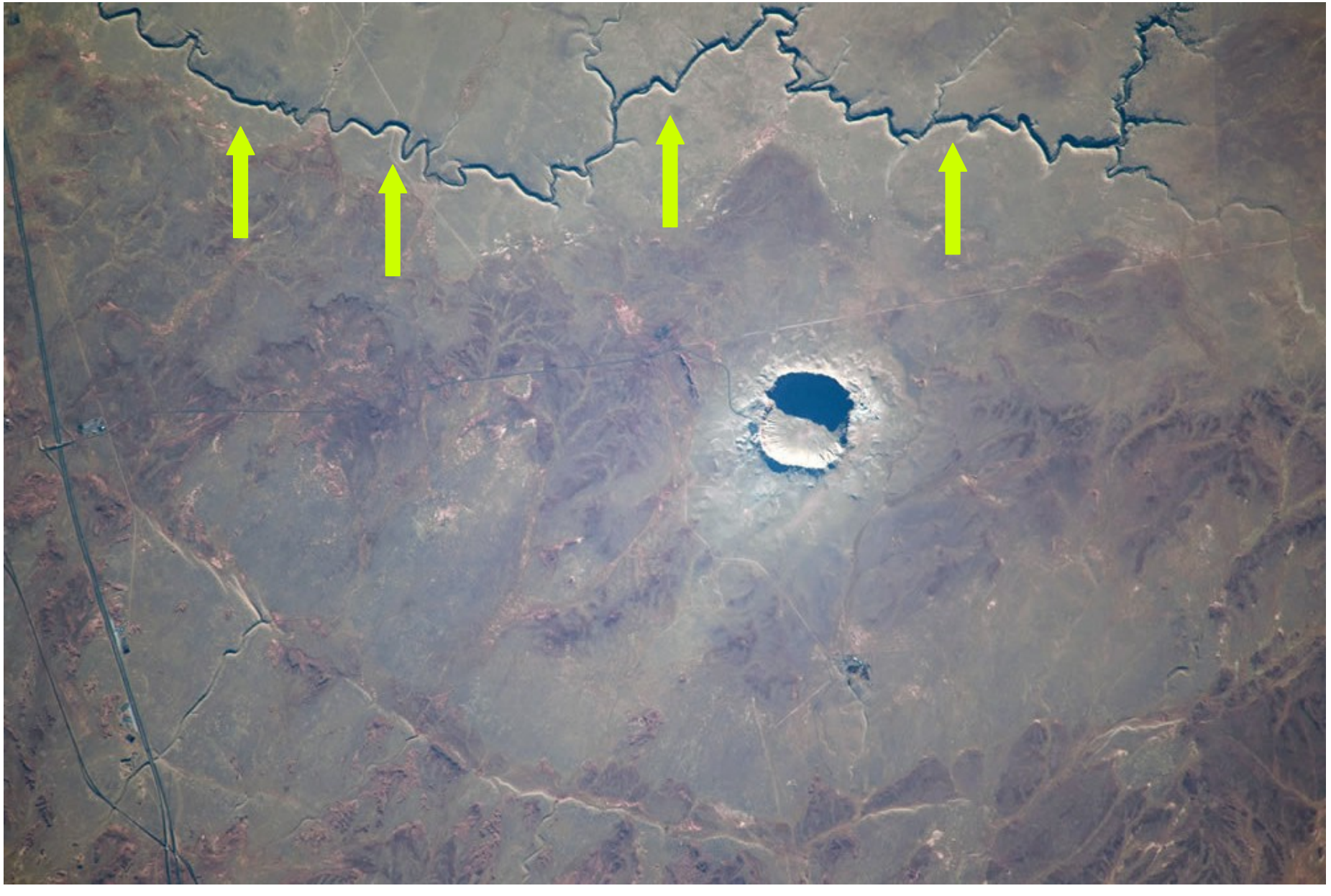
What’s so important about plate tectonics?

What's so important about plate tectonics?

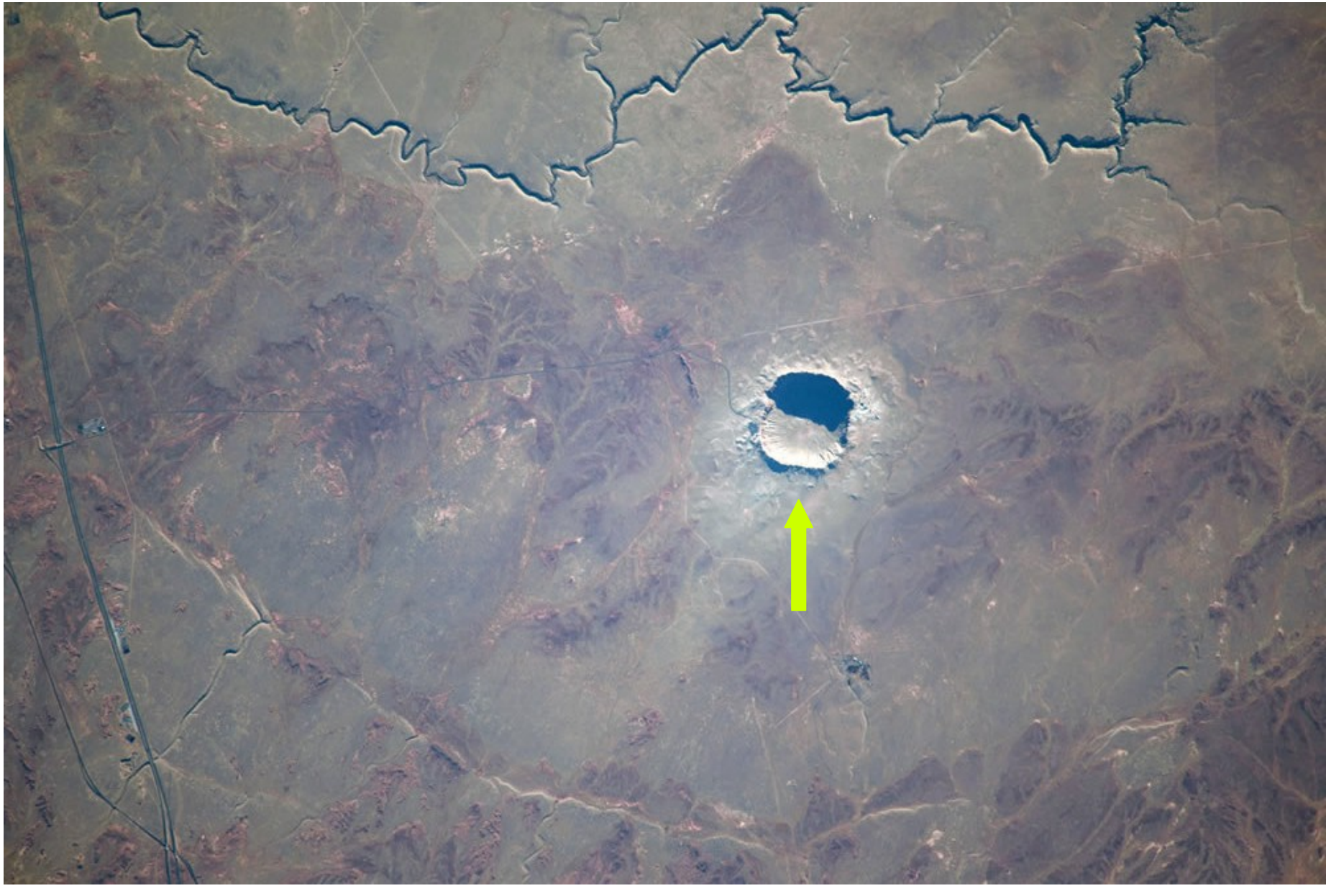
Plates boundaries create new land and remove old land.

Volcanoes: they emit gases, which means there will be an atmosphere.

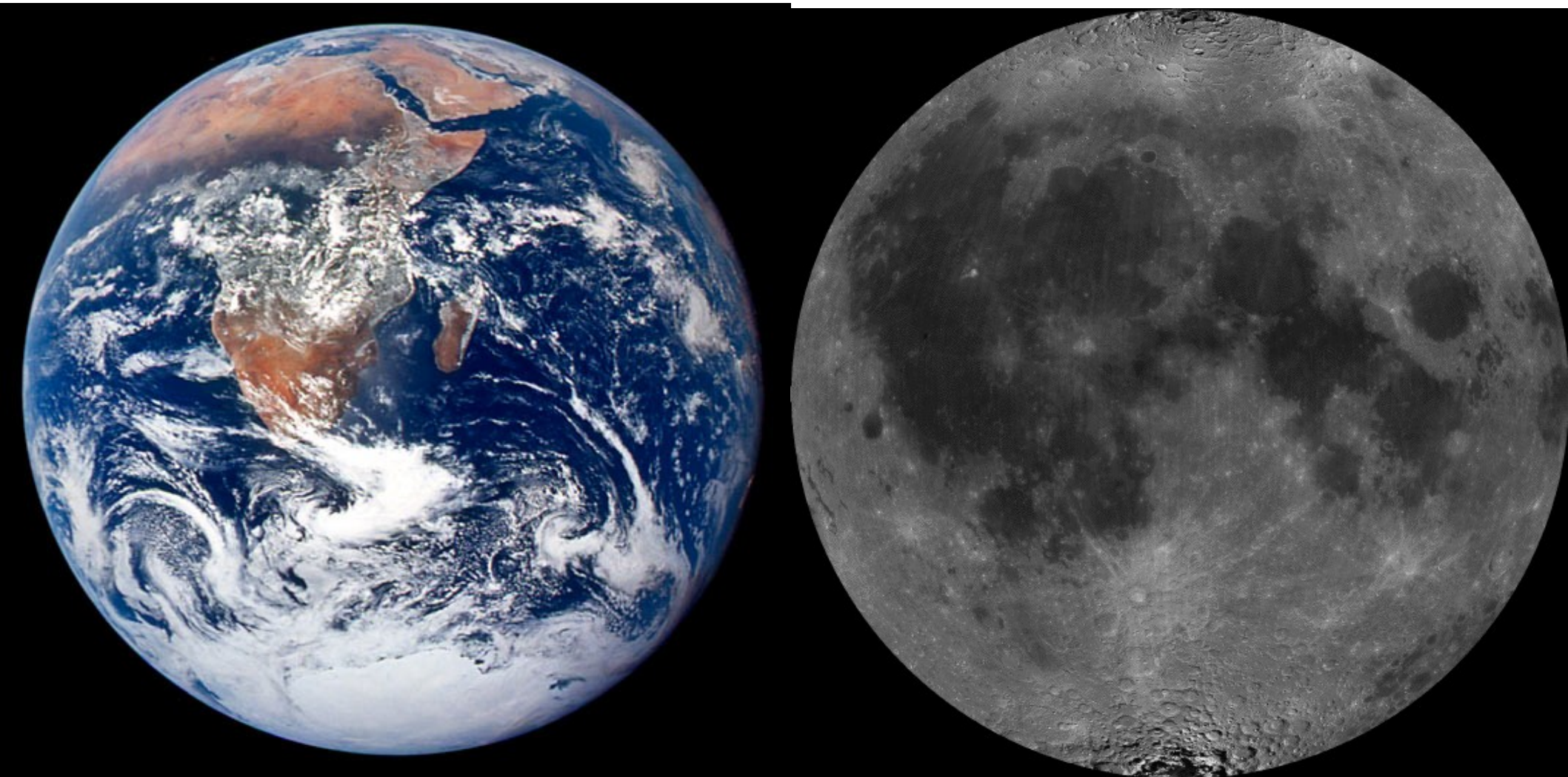
River bed (dry or wet), means liquids are or were flowing.



Crater: an impact. Something hit and has not been erased/covered.



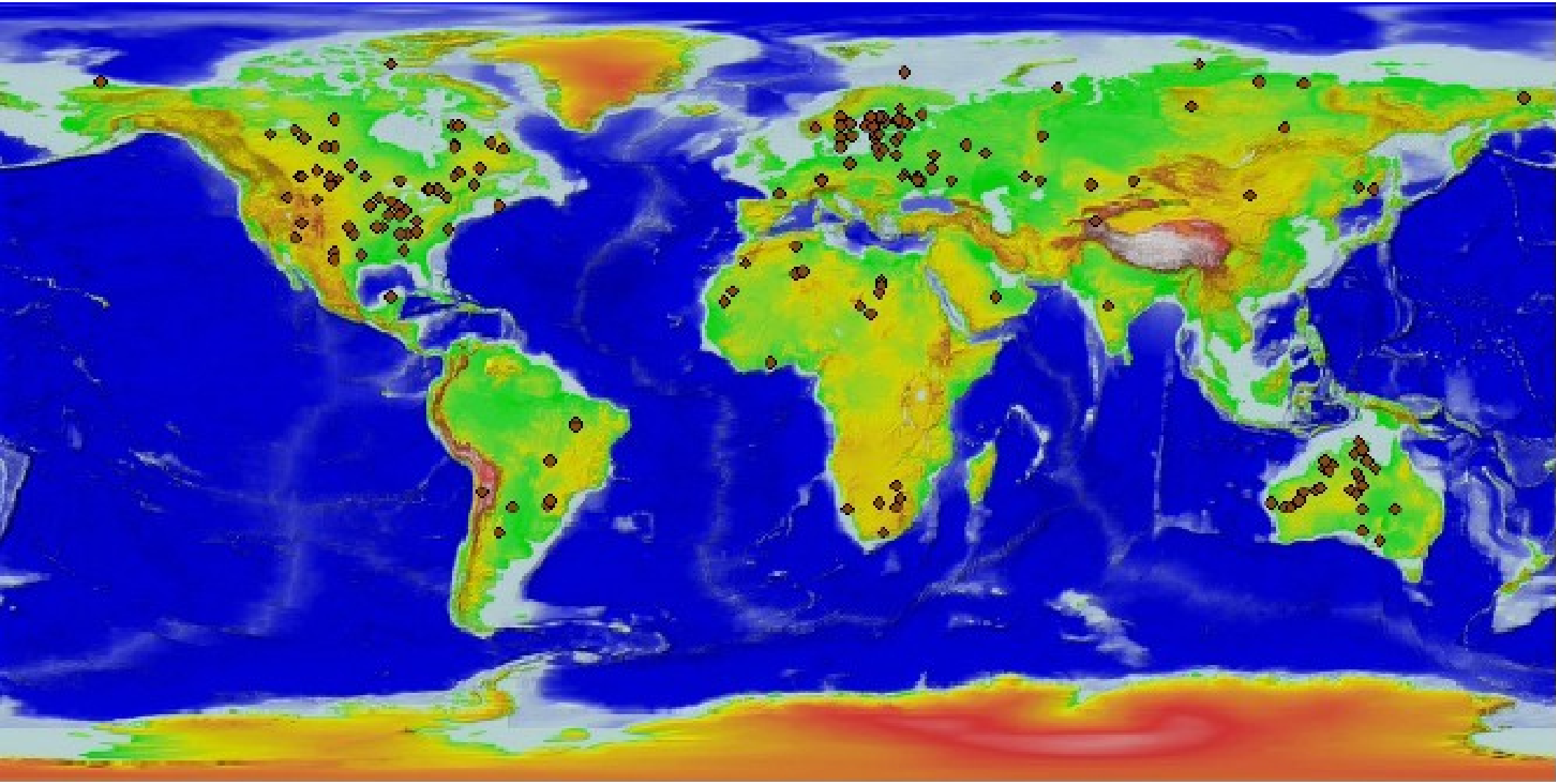
Which body is older, the Earth or the Moon? Is there a way to know for sure? **Yes, radioactive dating**

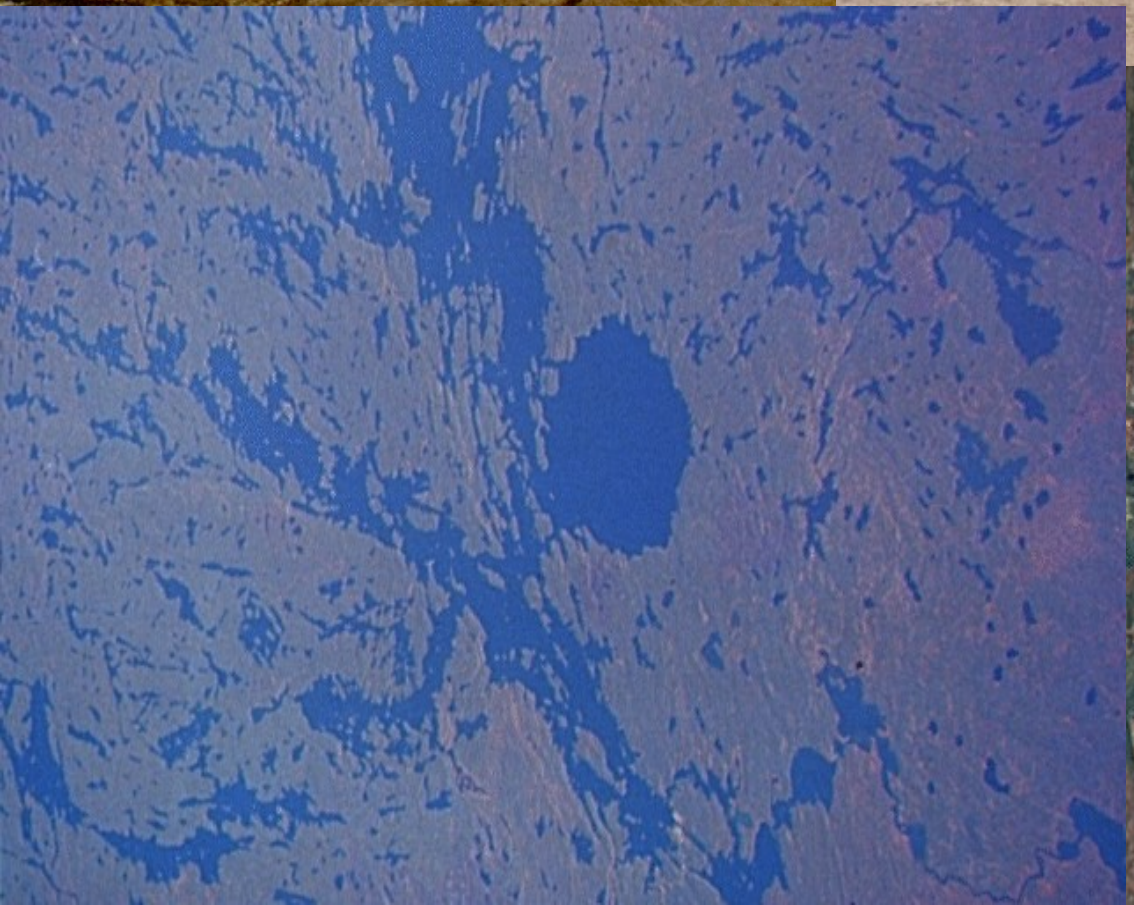


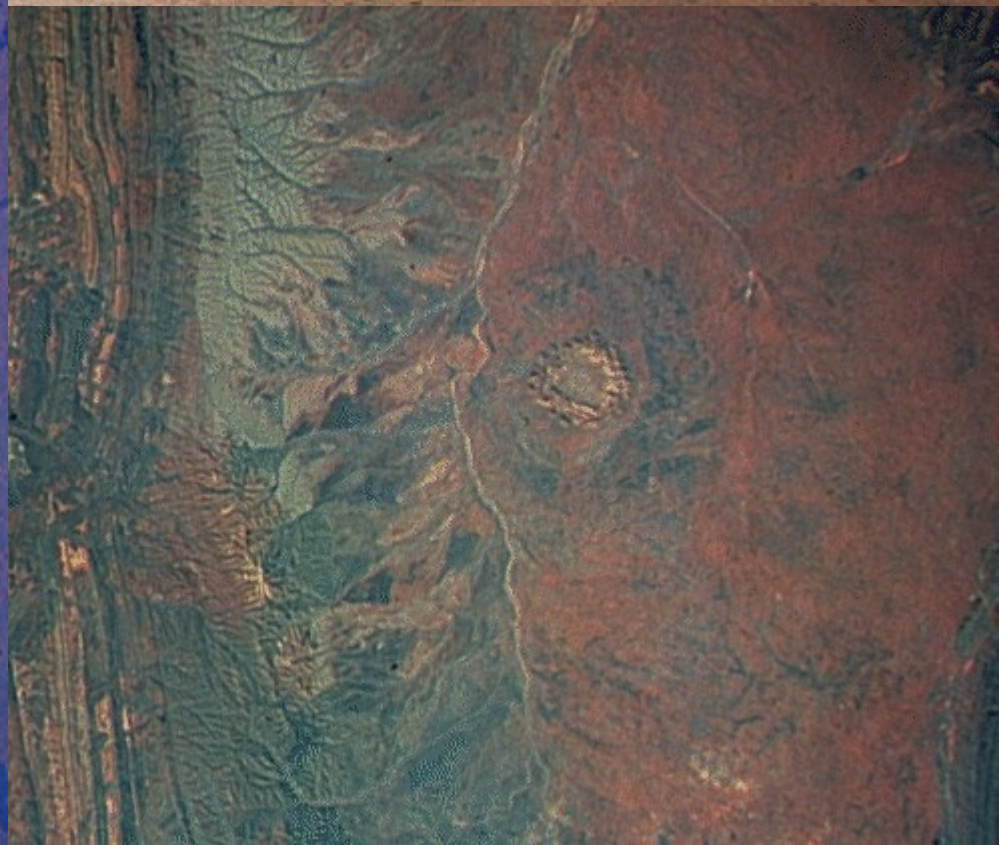
Why is the Moon smothered with craters, but the Earth isn't?

Erosion: resurfacing and weathering.

Craters on Earth





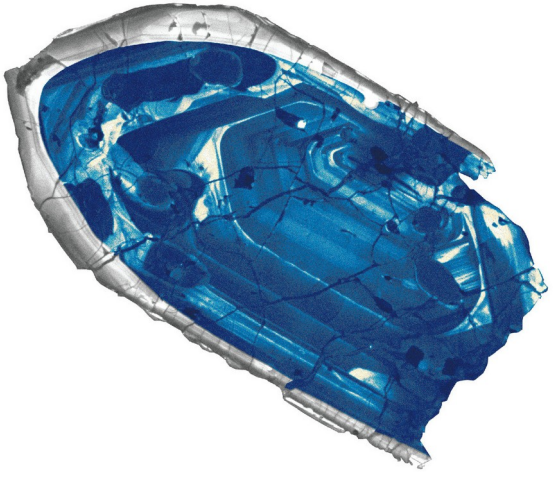


Back to: How can we determine the age of the Earth? For the surface

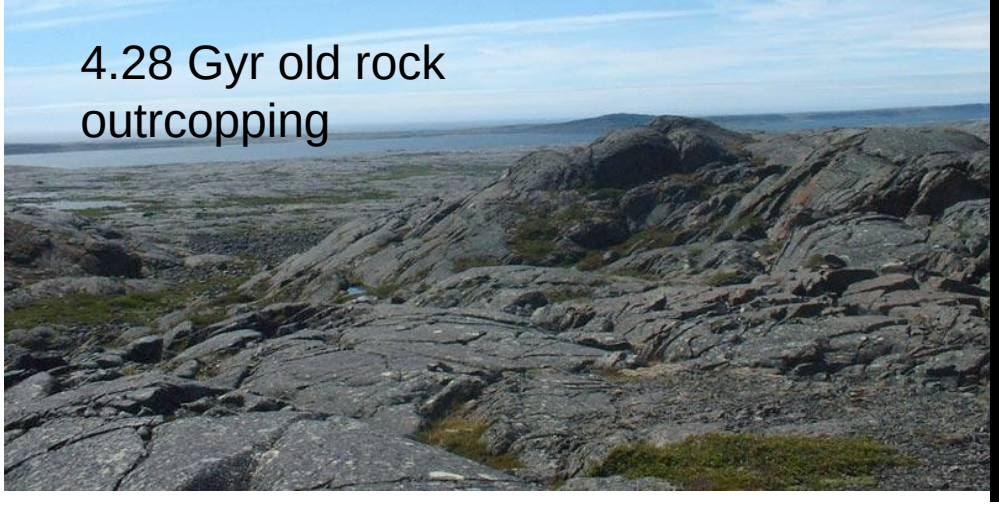
We can use radioactive (carbon) dating to tell how old rocks we find are. When rocks **solidify**, they lock-in the elements they are made of. The ½ life of Carbon 14 (when ½ of the original carbon would have been changed to nitrogen 14) is 5730 years. The ½ life of Potassium 40 (which decays to Argon 40) is 1.25 billion years.

How old is old?

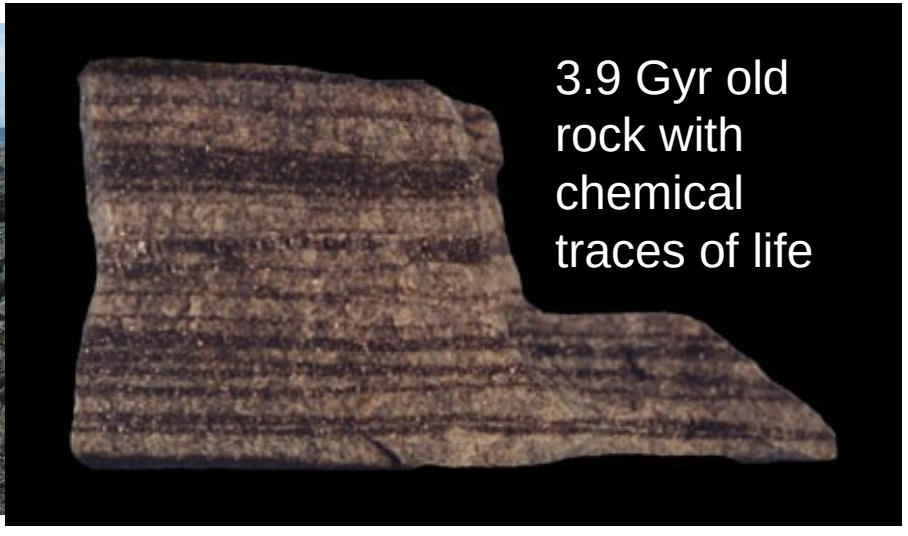
The oldest rocks found on Earth are about 4 billion years old. **Yet the average age of the Earth's surface is about 200 million years old.**



4.4 Gyr old mineral

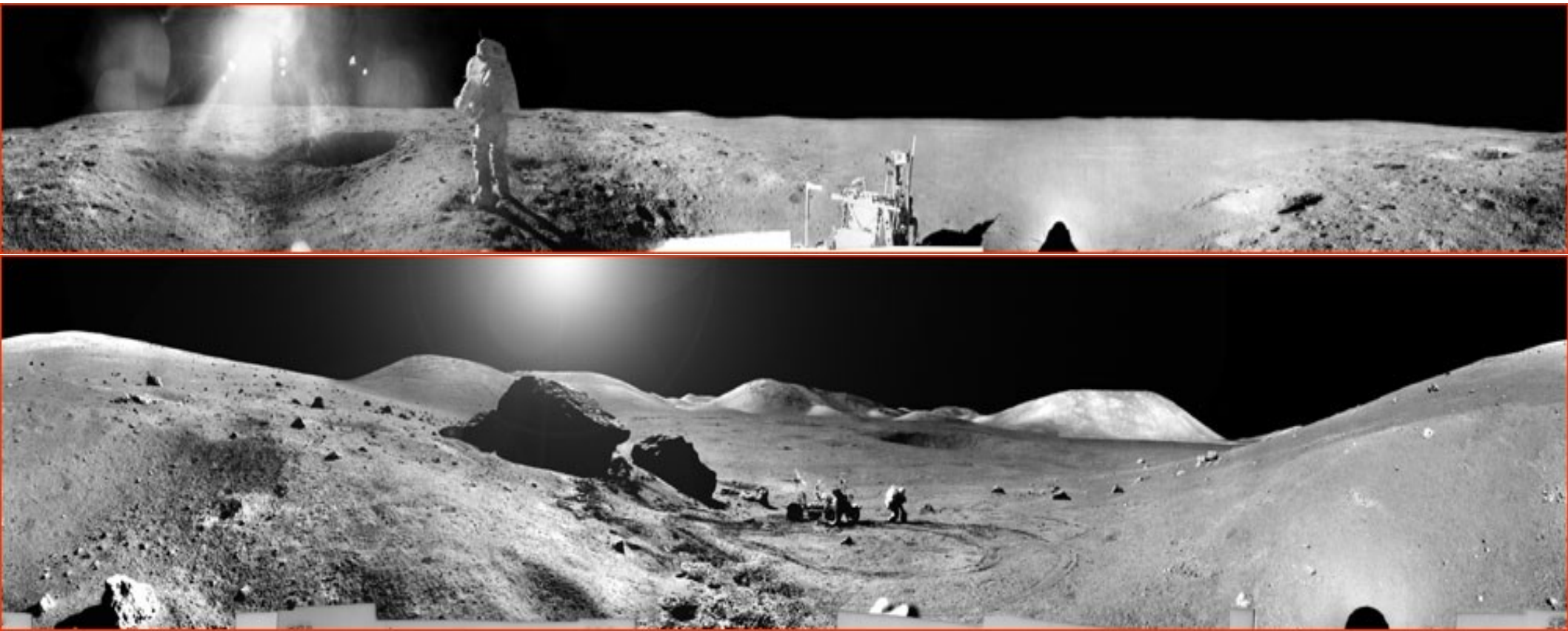


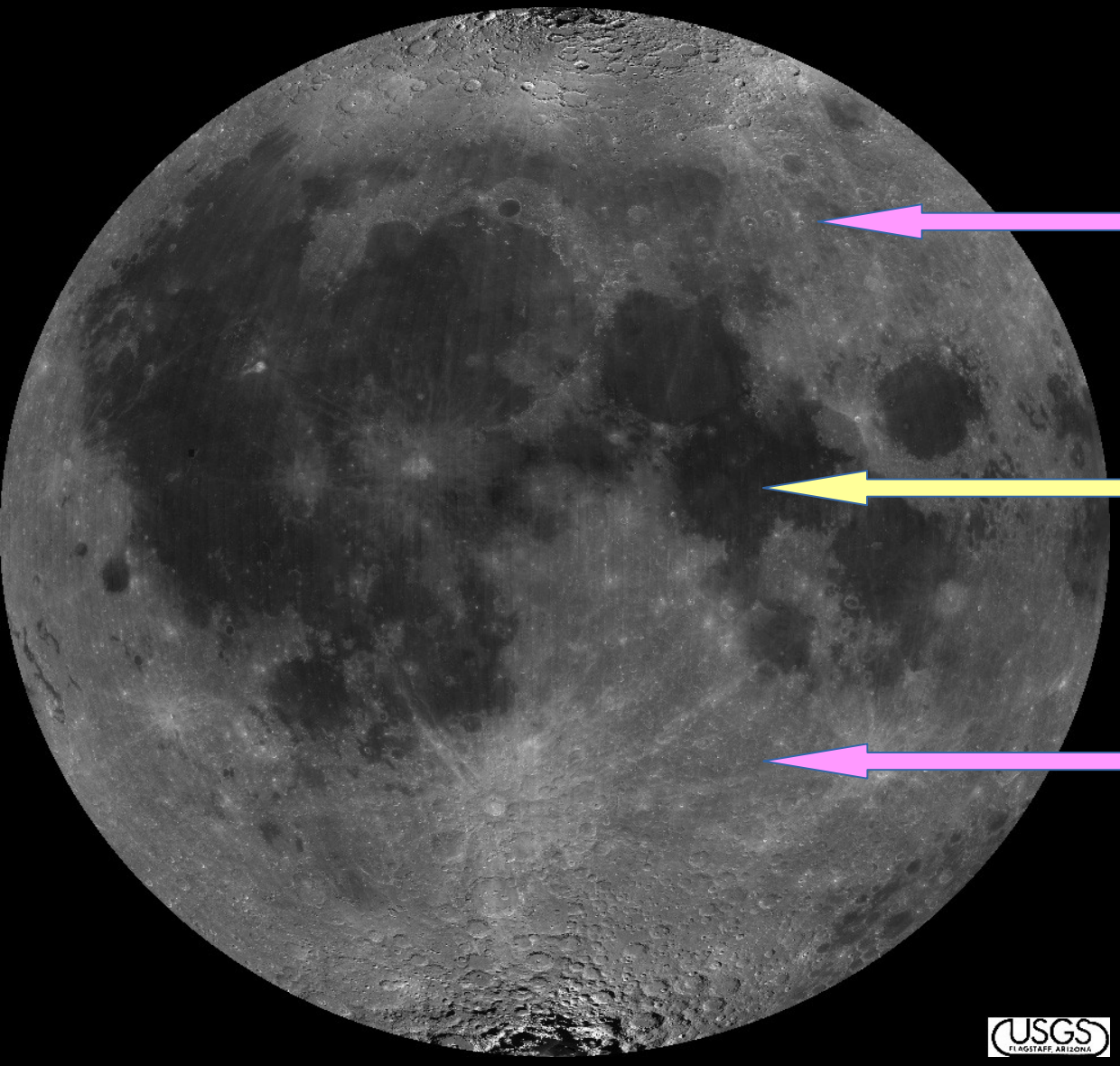
4.28 Gyr old rock outrcopping



3.9 Gyr old rock with chemical traces of life

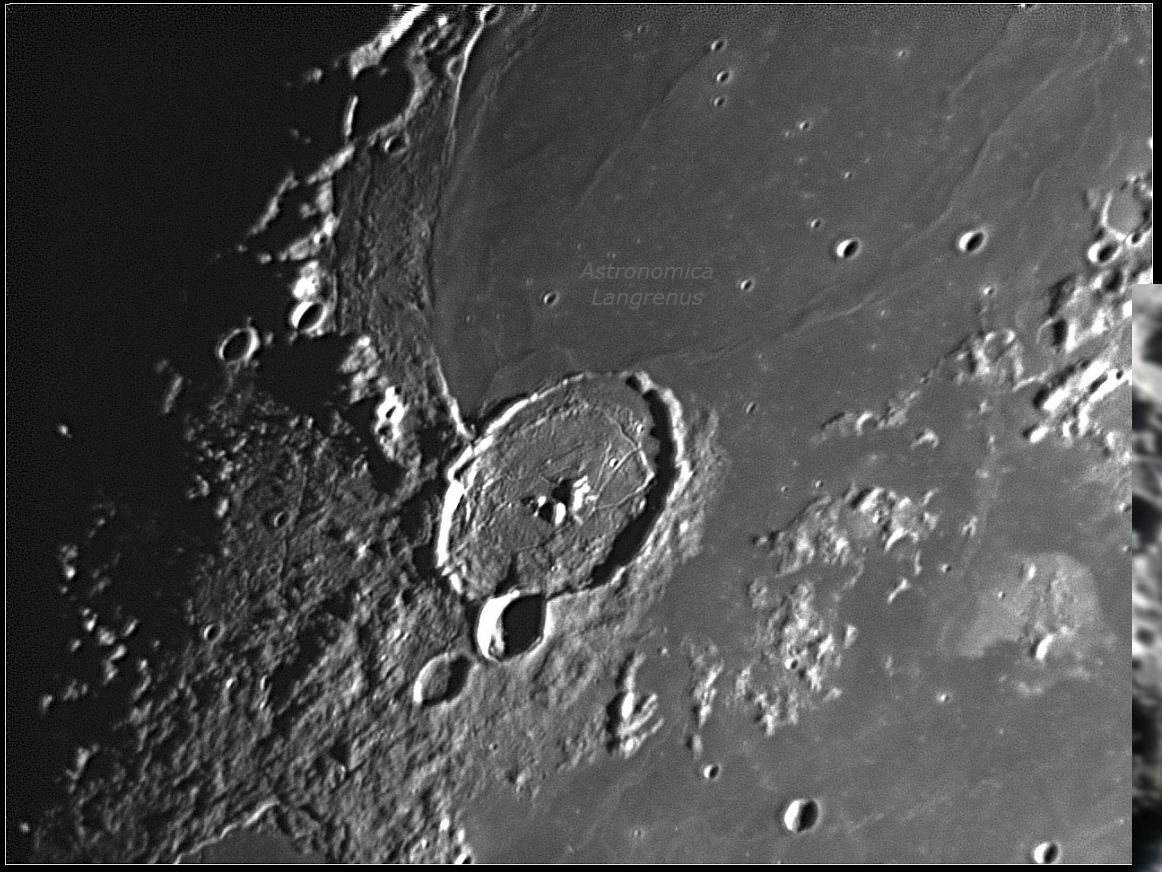
From Moonrocks, it has been determined that the highlands (light grey regions) are 4 to 4.5 billion years old and the maria (the darker regions) are about 3.5 billion years old.





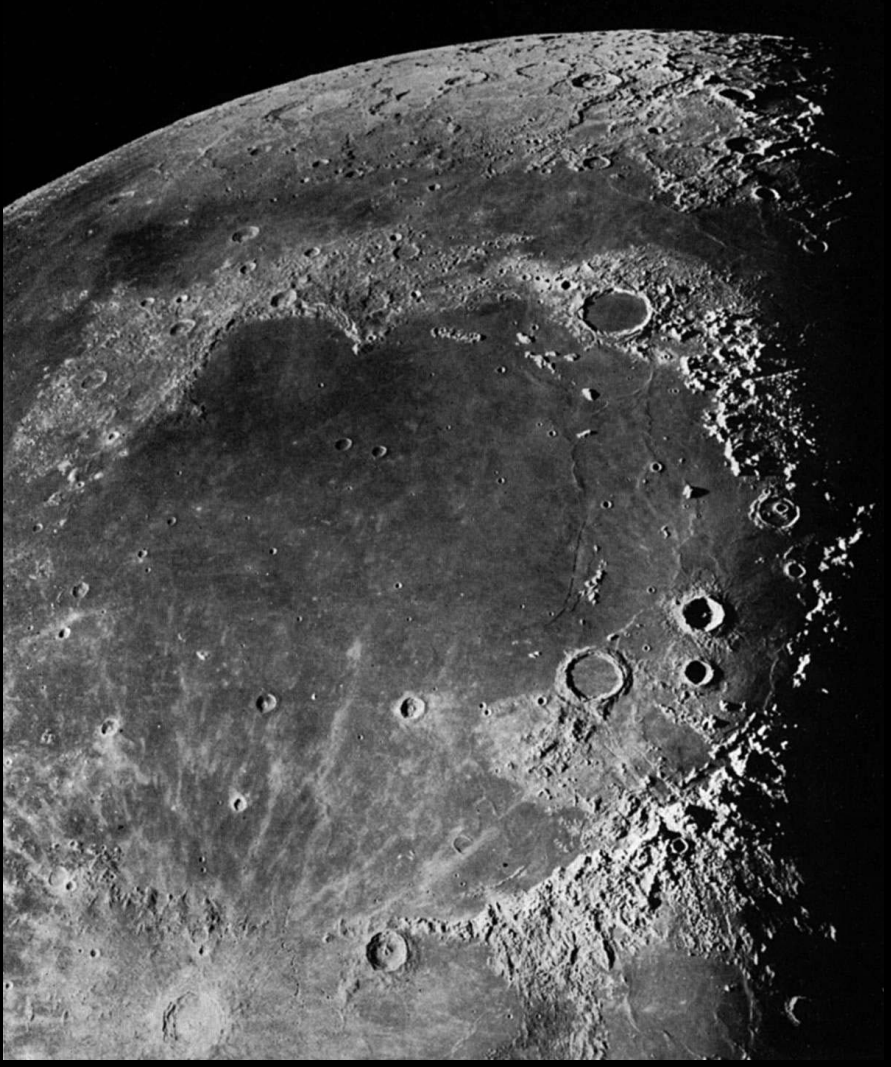
Tight age around 3.5 Gyrs

Ages between 4 and 4.5 Gyrs



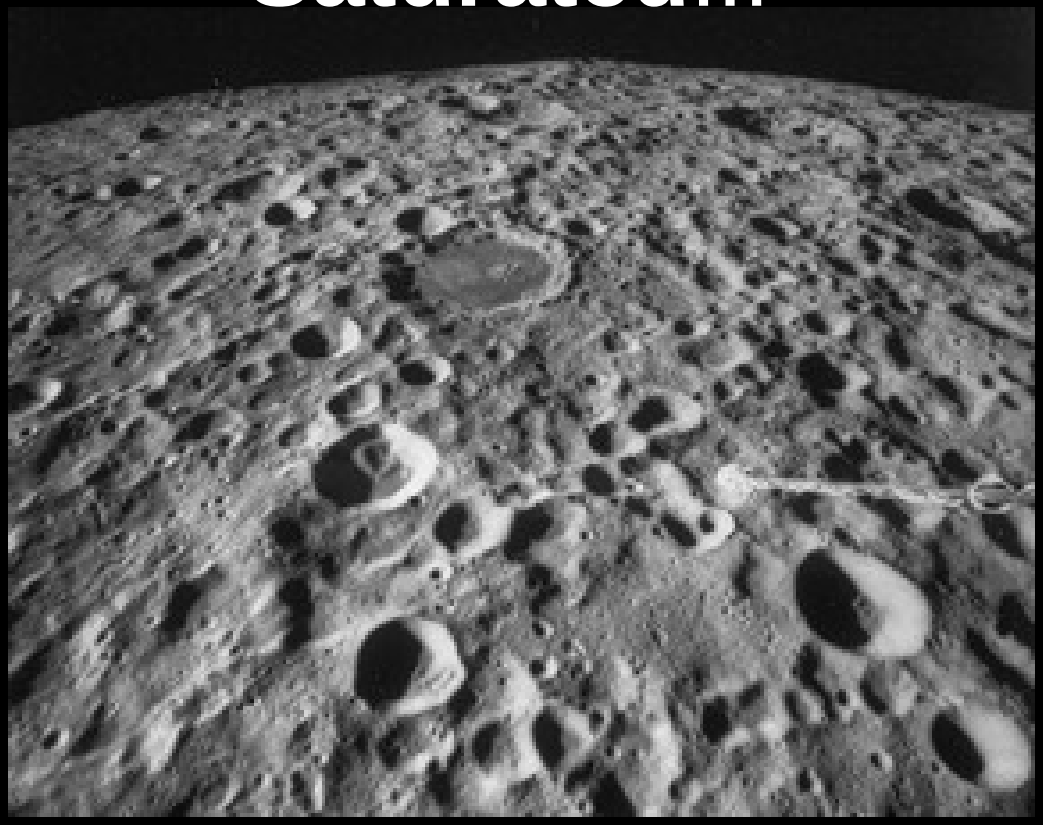
Maria

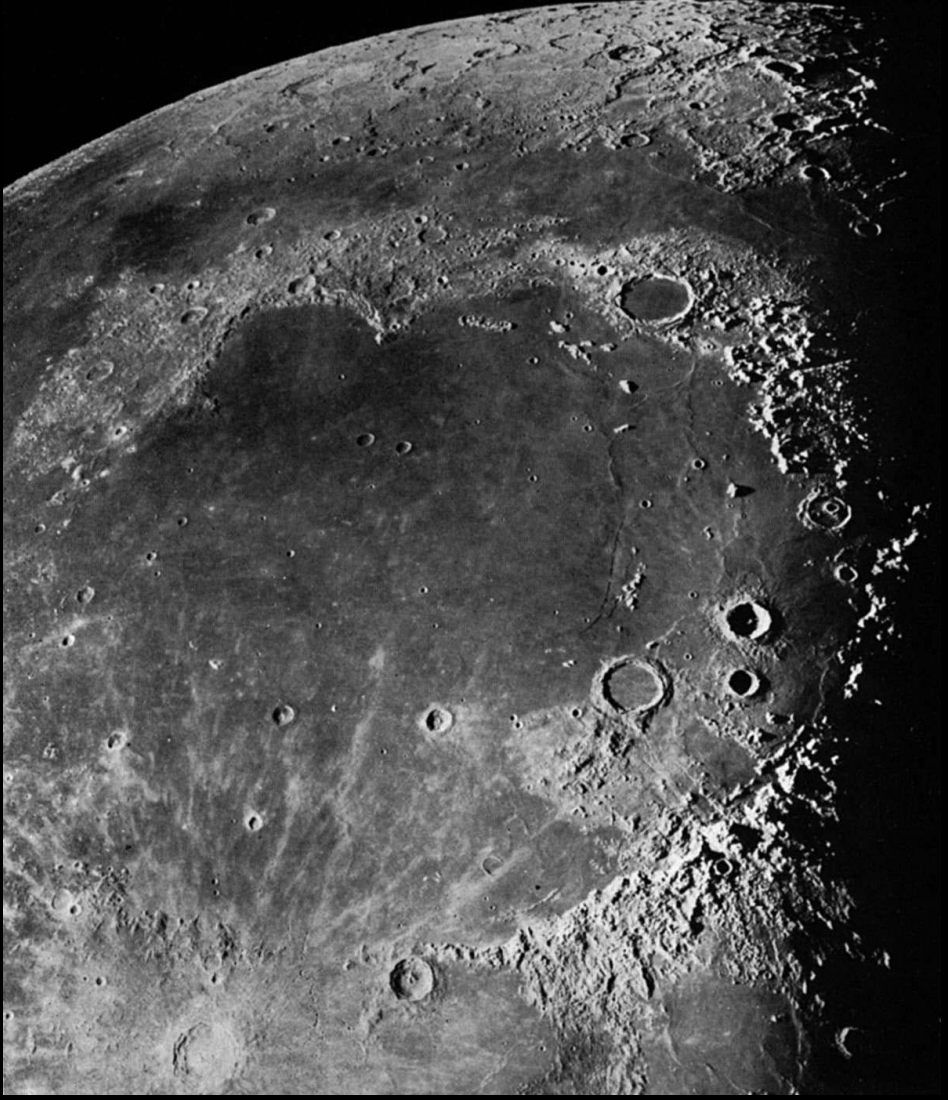
Highlands



The mare are **moderately** cratered.

The highlands are smothered in craters. **Saturated**!!!





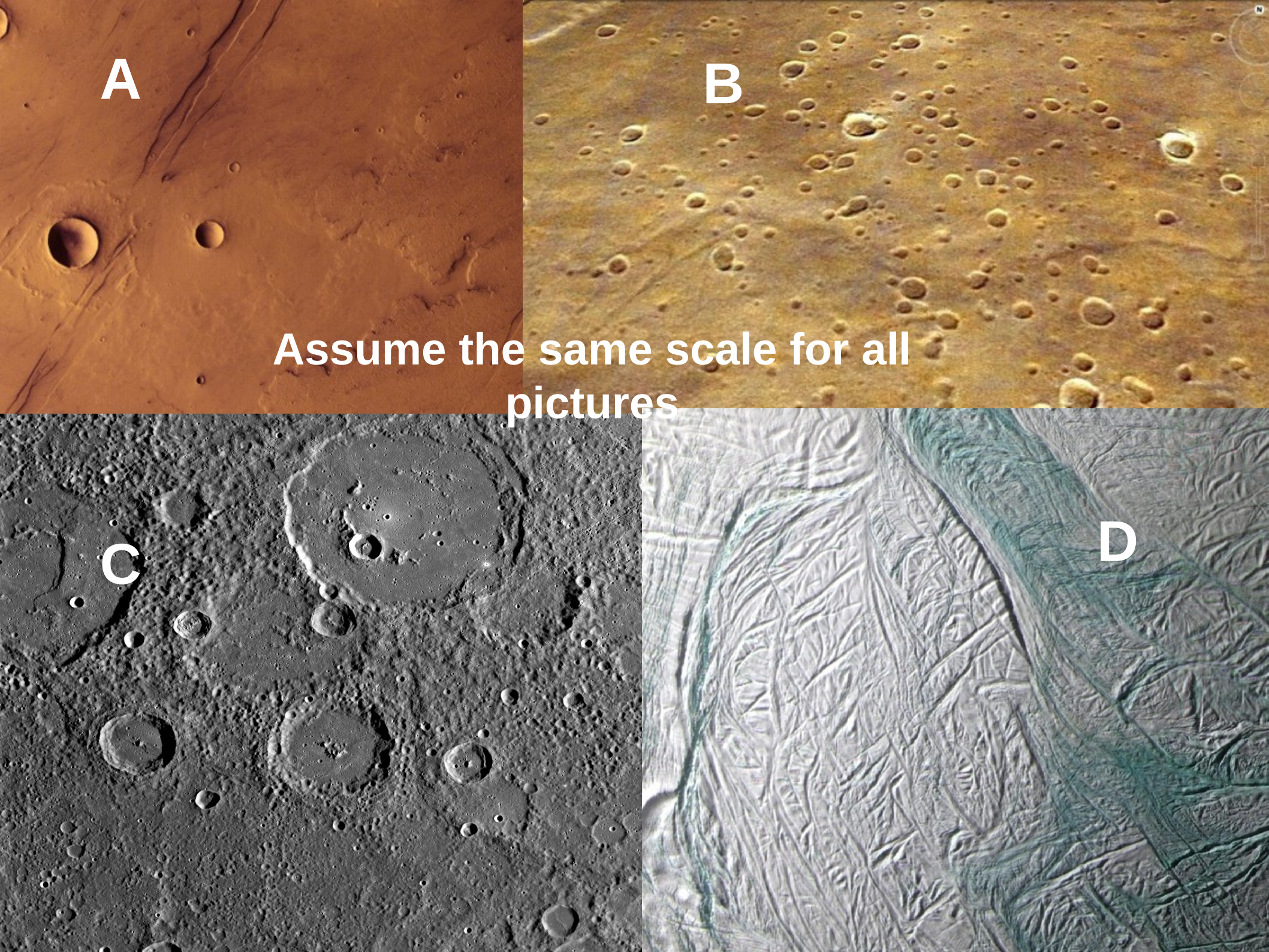
3.5 Gyrs

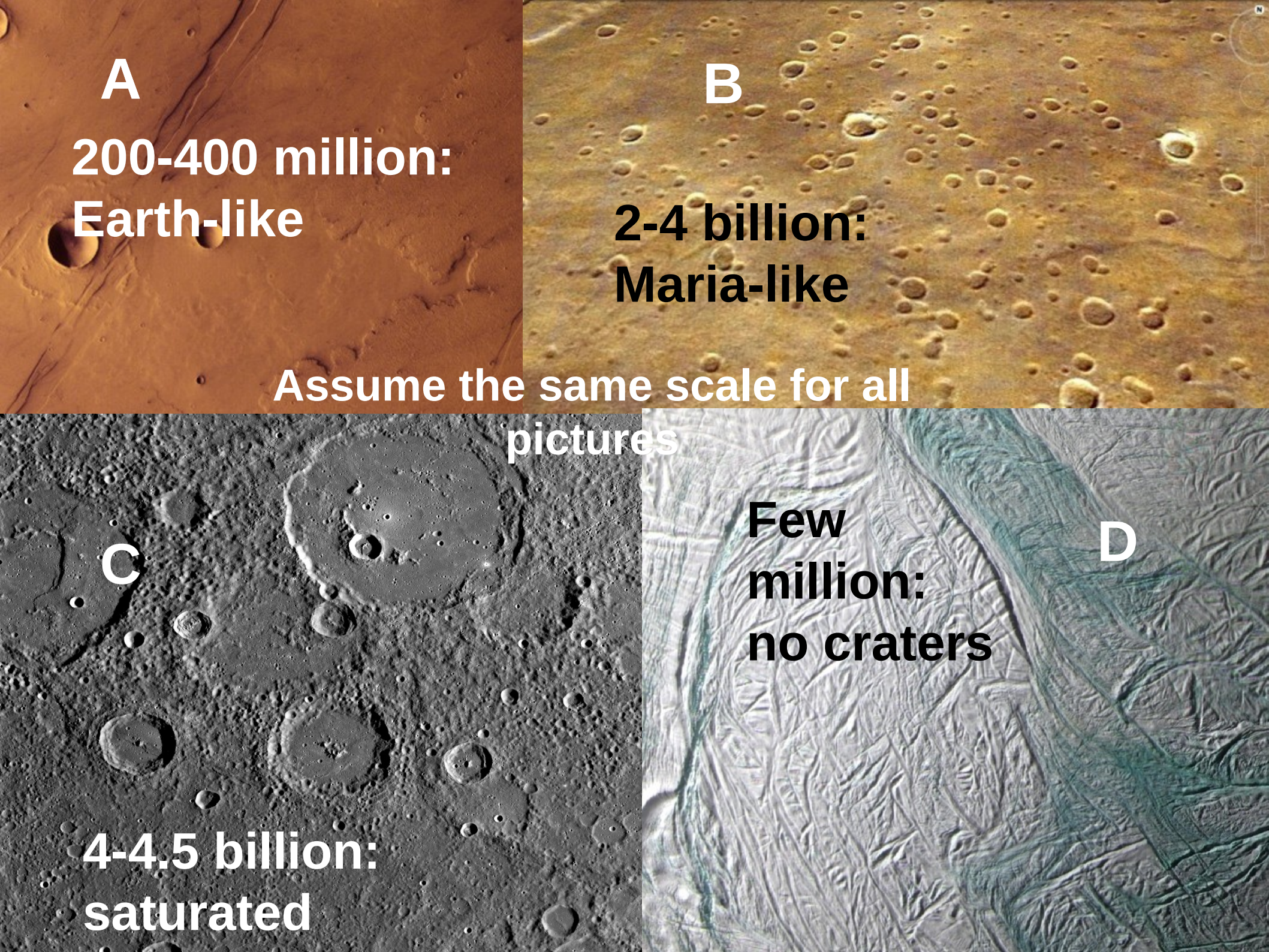
4-4.5 Gyrs

Surface age based on cratering

1) Smothered with craters; the surface is 4-4.5 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.

This is the yardstick against which all surface ages will be measured.


A
B
Assume the same scale for all pictures
C
D


A
200-400 million:
Earth-like
B
2-4 billion:
Maria-like
Assume the same scale for all pictures
C
4-4.5 billion:
saturated
Few
million:
no craters
D

How old is the Earth, as a whole?

Current estimate: 4.6 billion years old.

Most meteorites are 4.5-4.6 billion years old.

How old is the Earth, as a whole?

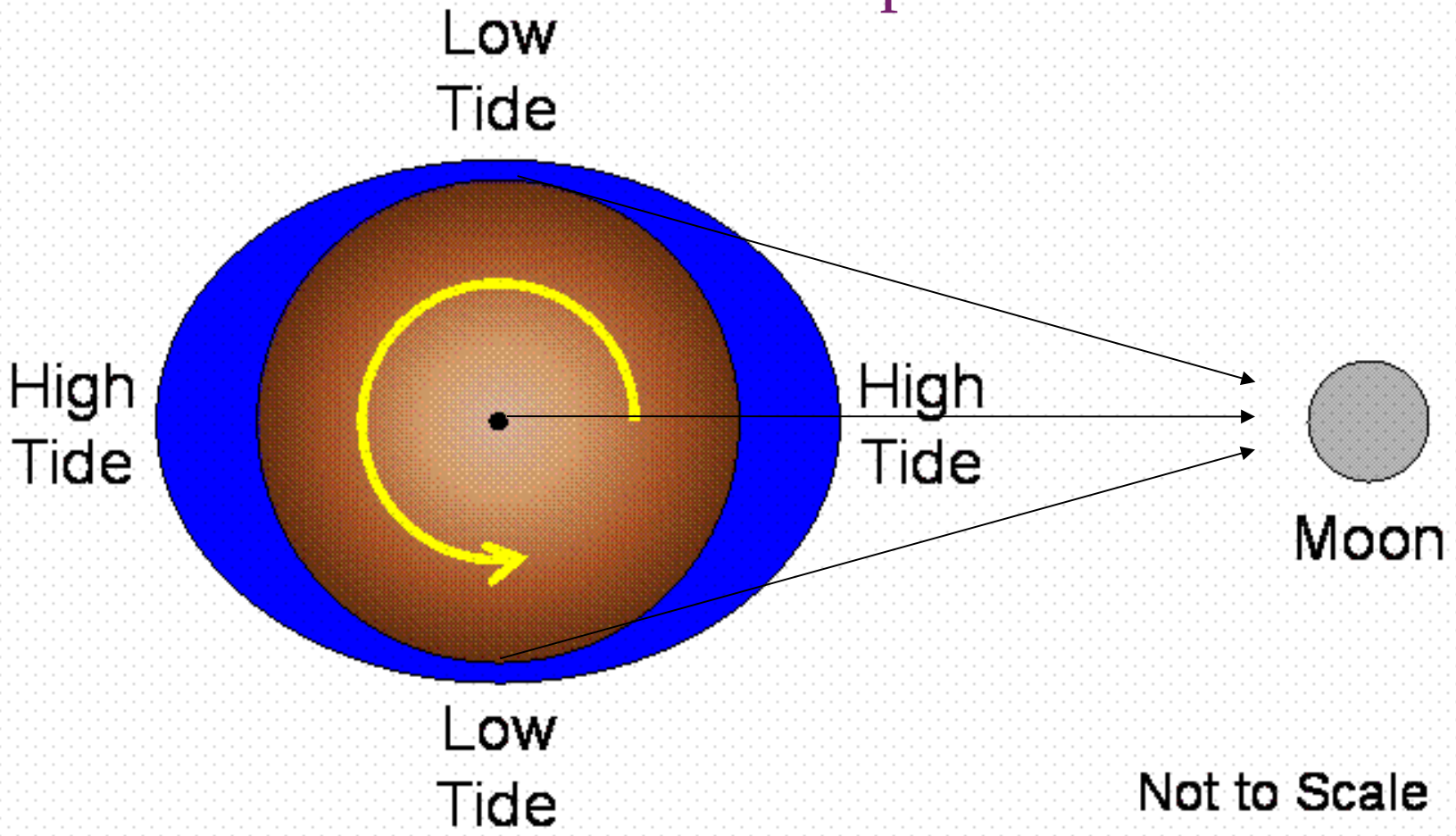
Current estimate: 4.6 billion years old.

This is the estimate for the age of our solar system as a whole.

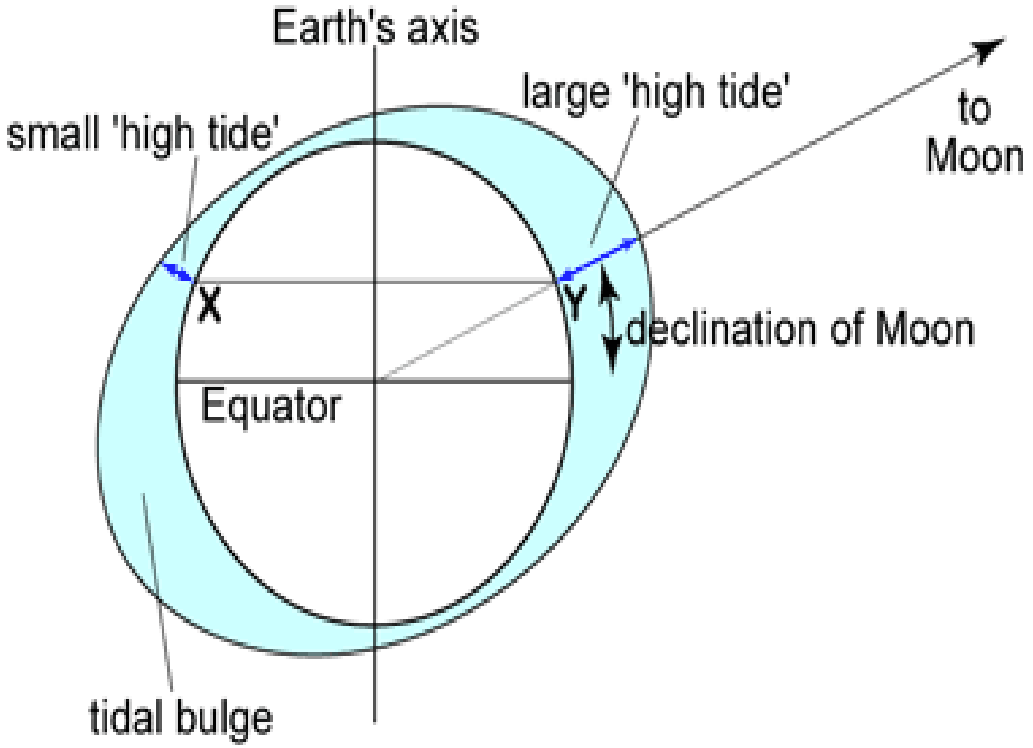
Tides

The Moon's gravity pulls the Earth. At the middle, it's pulled straight, but at the poles, it's pulled slightly inward. This squeezes the Earth and makes tides.

The same occurs for some other planets/moons.



But the Earth spins faster than the Moon orbits, so the bulge does not point directly at the Moon.



It points slightly ahead of the Moon.

Consequences:

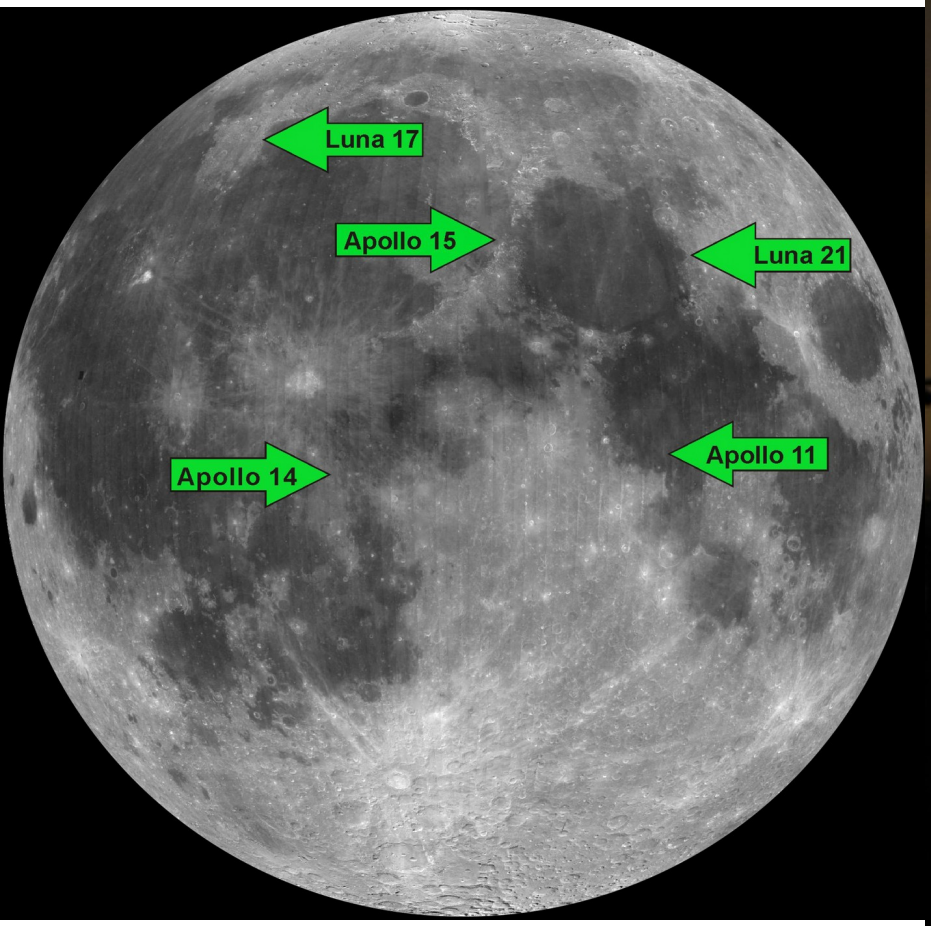
The bulge is a forward pull on the Moon's orbit and a backwards pull on the Earth's spin.

Consequences:

The bulge is a forward pull on the Moon's orbit and a backwards pull on the Earth's spin.

The Moon's orbit is getting larger (the Moon's distance increases about 3 cm/year) and therefore longer.

Laser ranging the Moon



Consequences:

The bulge is a forward pull on the Moon's orbit and a backwards pull on the Earth's spin.

The Earth's spin is slowing, so days are getting longer (1.5 msec/century).

Consequences:

The bulge is a forward pull on the Moon's orbit and a backwards pull on the Earth's spin.

Eventually, the Earth will be tidally locked to the Moon, just as the Moon is tidally locked to the Earth. Then, 1 Earth day will equal 1 Moon orbit (about 30 current Earth days).

The Moon is tidally locked to the Earth: It spins at the same rate of its orbit. So 1 side always faces the Earth.

Consequences:

If the Moon is now slowing down the spin of the Earth. If we go backwards in time, the spin of the Earth would be….

Consequences:

If the Moon is now slowing down the spin of the Earth. If we go backwards in time, the spin of the Earth would be….faster!

The original Earth day (post-Moon creation) was about 10 hours long.

For dinosaurs (65Myrs ago), the day was about 22 hours long. (Confirmed from shellfish and coral growth.)

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!!!!