

A satellite with a large white parabolic antenna and solar panels is shown in space. The Earth is visible in the upper left, and the Moon's surface is in the lower right. The satellite is covered in gold thermal insulation.

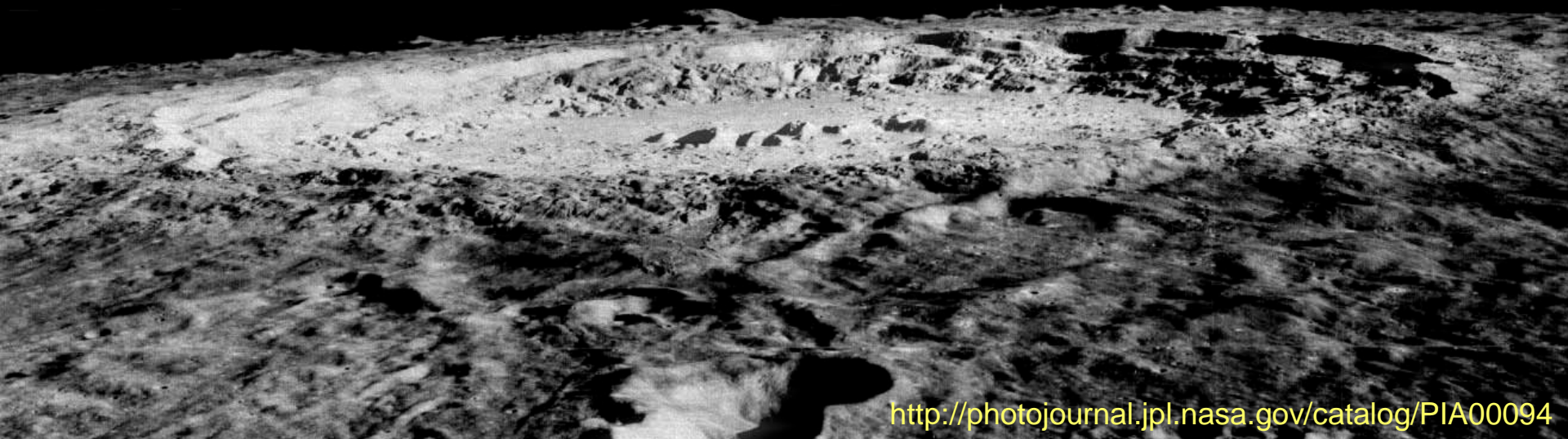
Welcome!

EXPLORE!

To the Moon and
Beyond!

Earth's Moon

- How did our Moon form?
- What's been happening since?



A few data to ponder

Lower density – “lighter” -
relative to planets

Less iron than whole Earth,
more aluminum and
titanium

Moon's chemical signature ~
Earth's mantle



A few more data to ponder

Does not orbit in equatorial
plane of Earth, or ecliptic

Earth/Moon - high angular
momentum



How Did the Moon Form?

Lunar Formation Models

Capture

**Binary
Accretion**

Fission

Lunar Formation Models

Capture

Hard to put
the breaks
on – slow
Moon

Fission

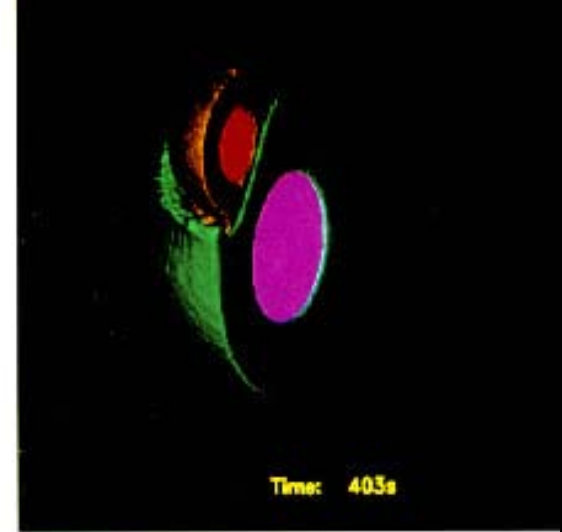
Wasn't
spinning
fast
enough

Binary Accretion

Chemical
differences
and orbit
differences

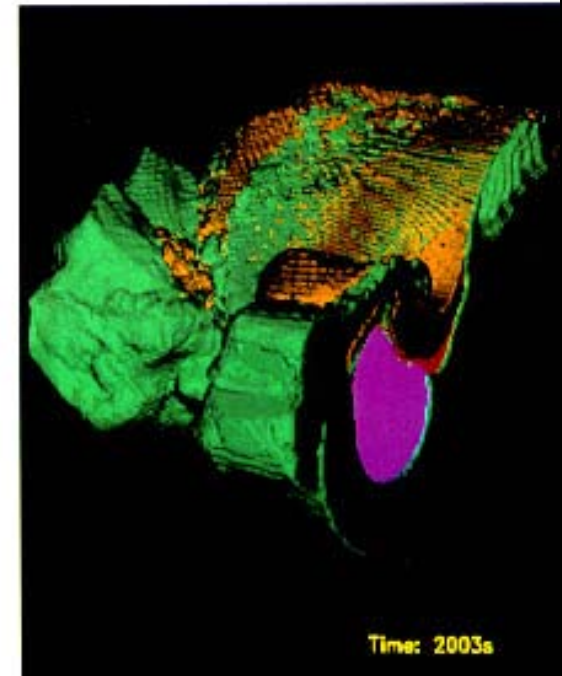
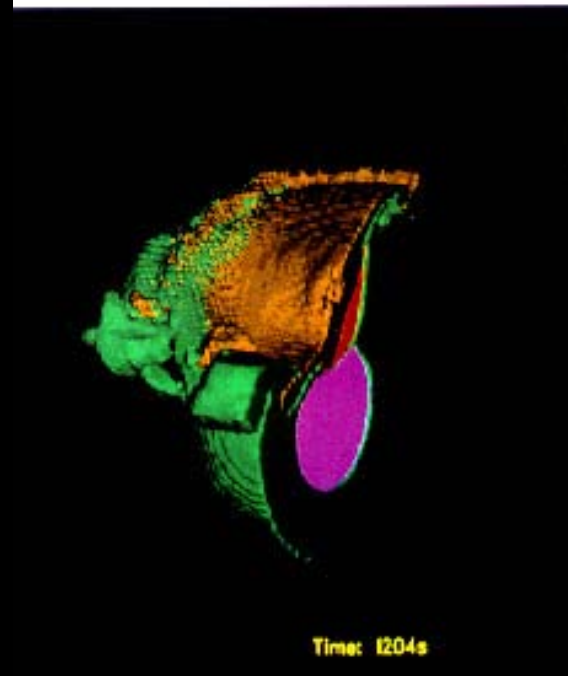
Impact by *Mars-sized* proto-planet

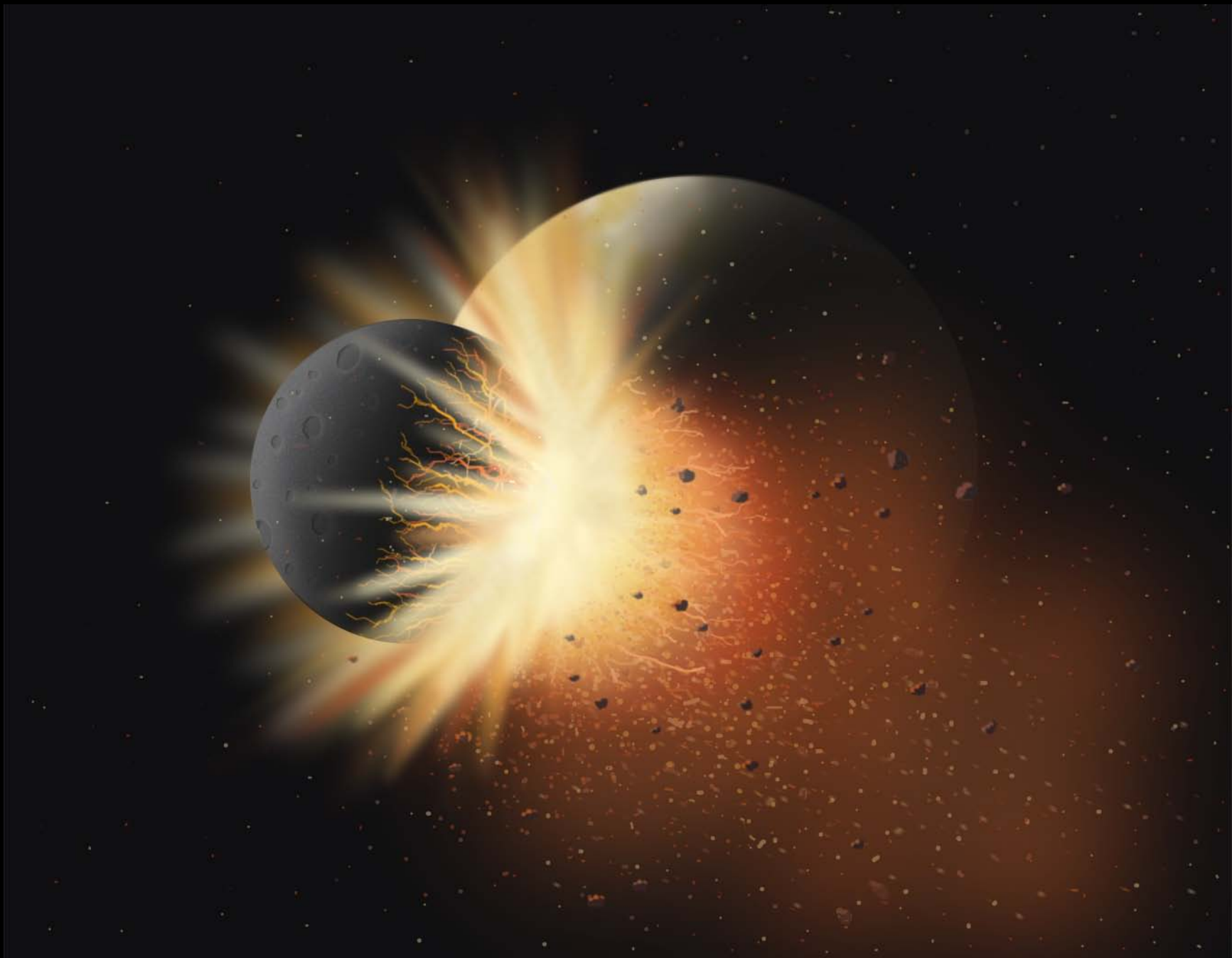
4.5 billion years ago

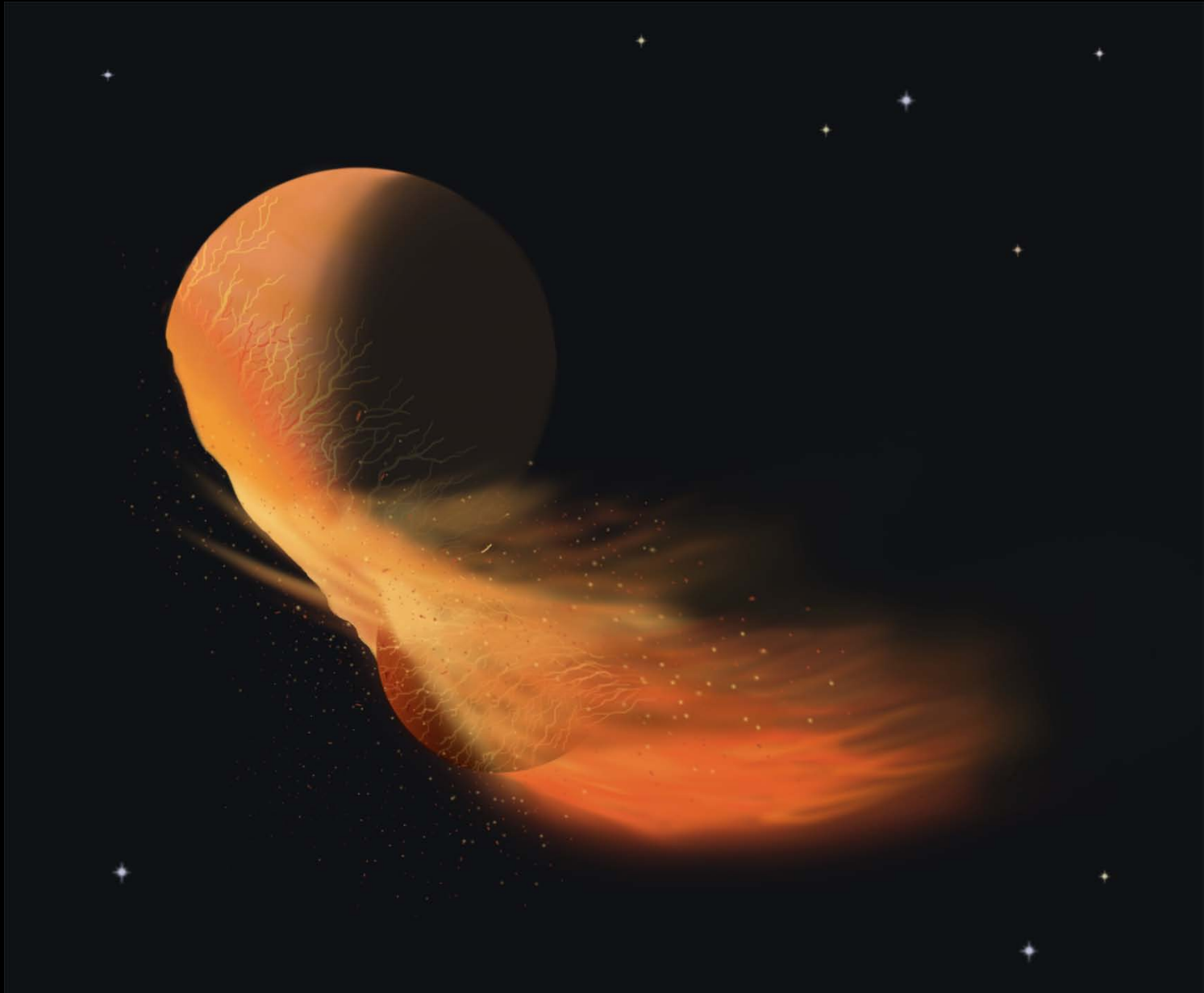


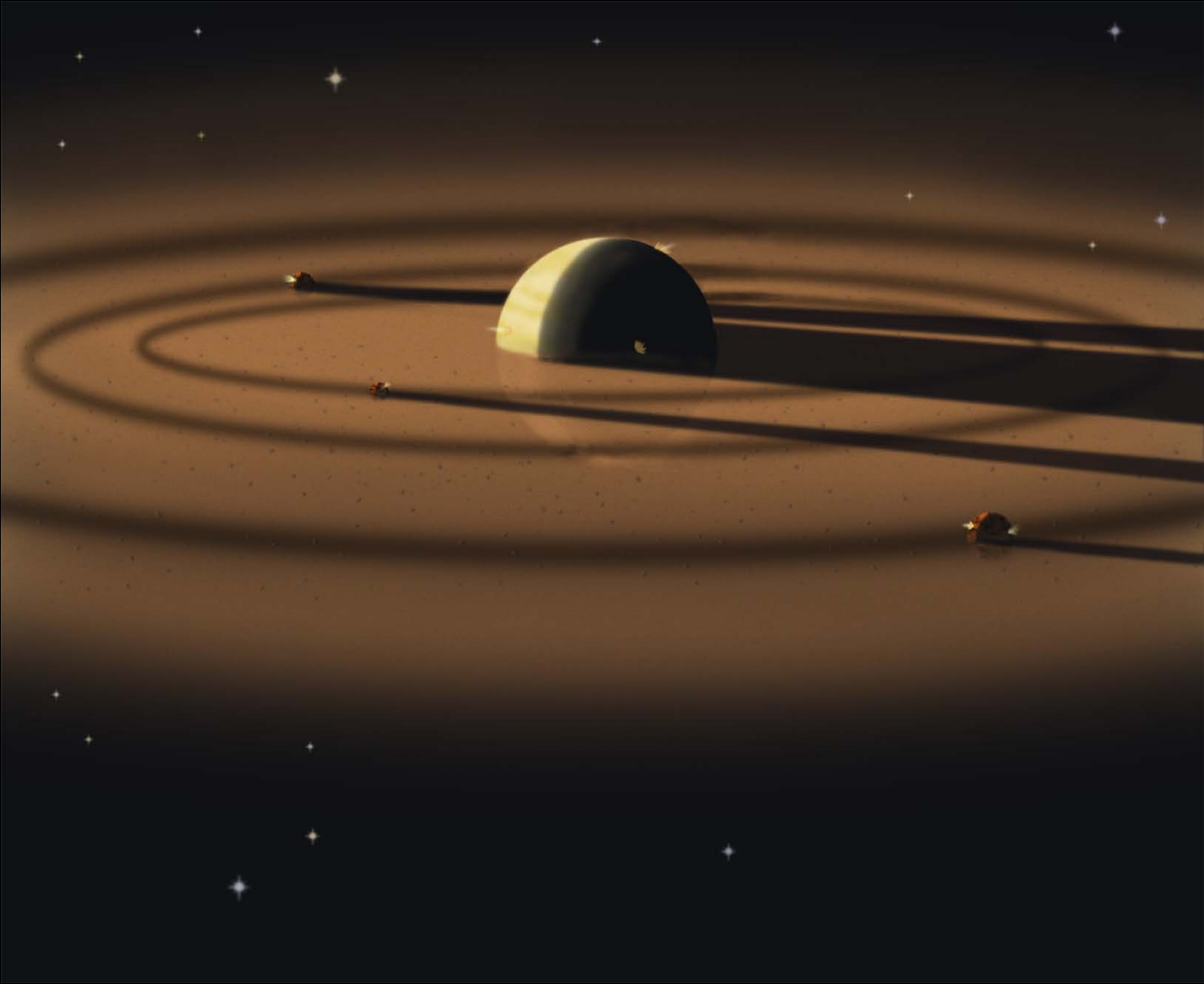
Explains:

- Chemistry
- Orbit
- High angular momentum







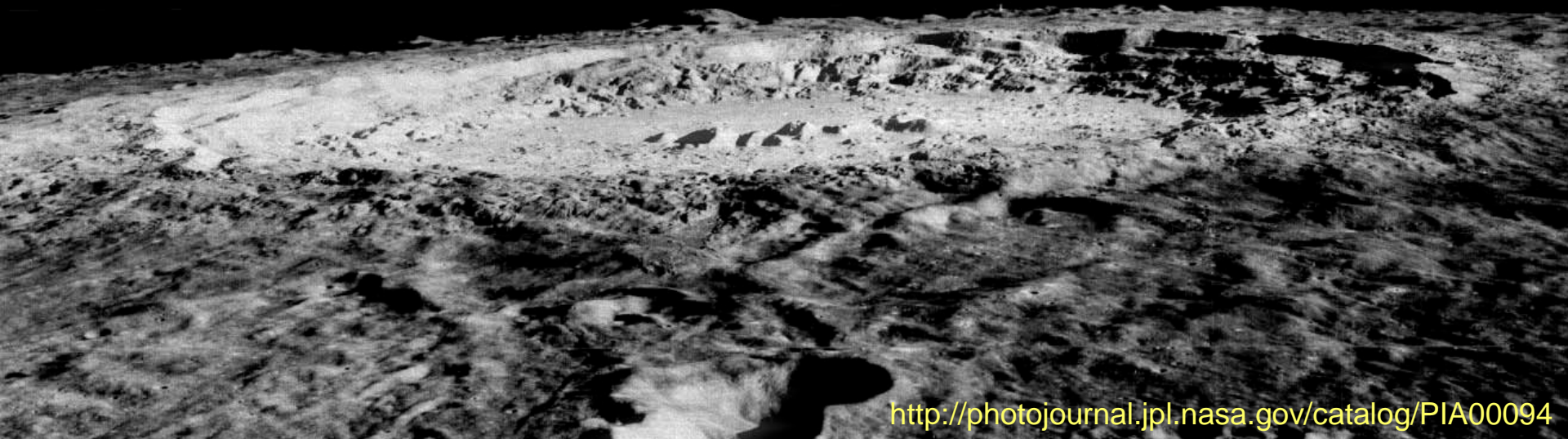




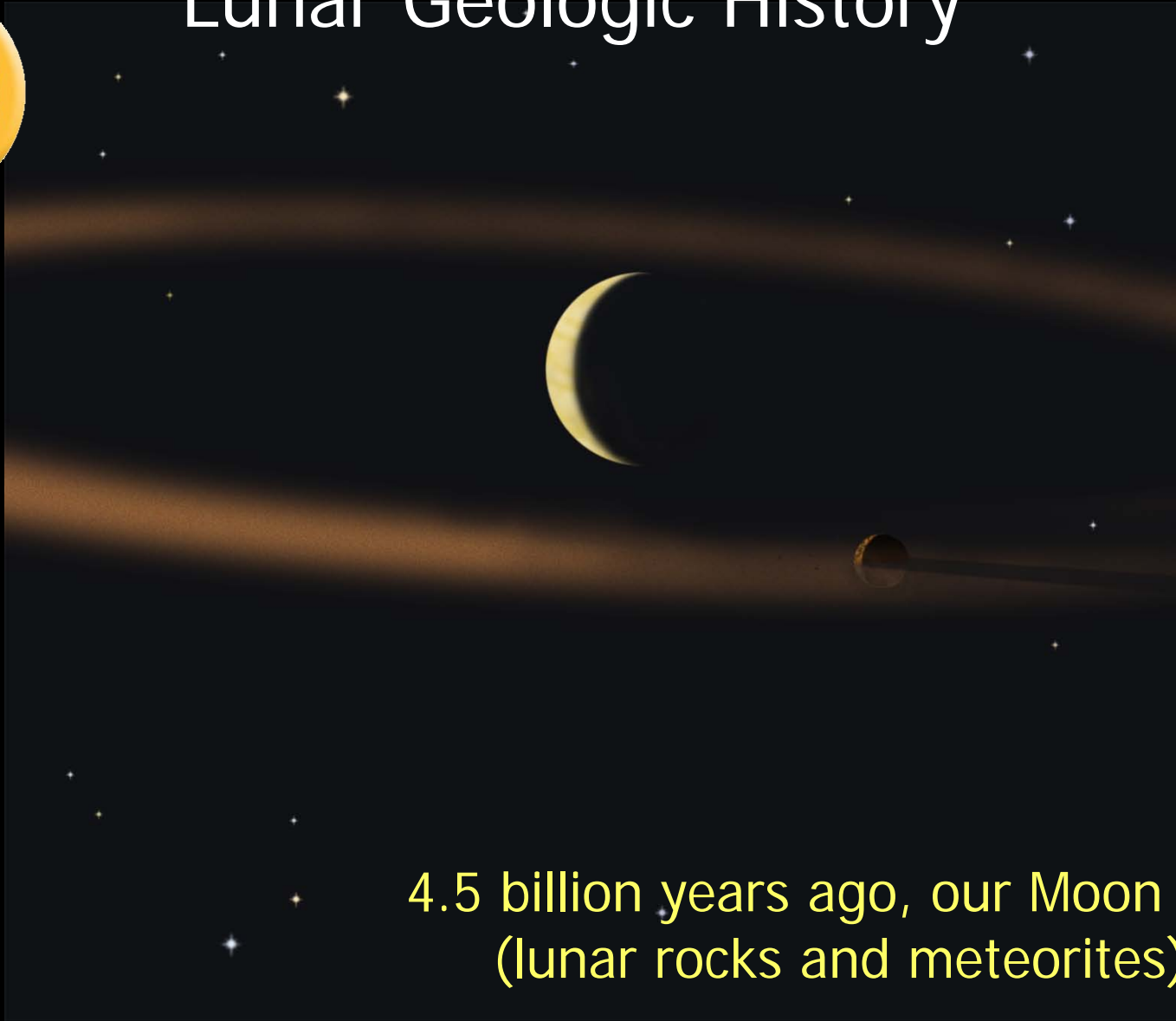


Earth's Moon

- How did our Moon form?
- What's been happening since?



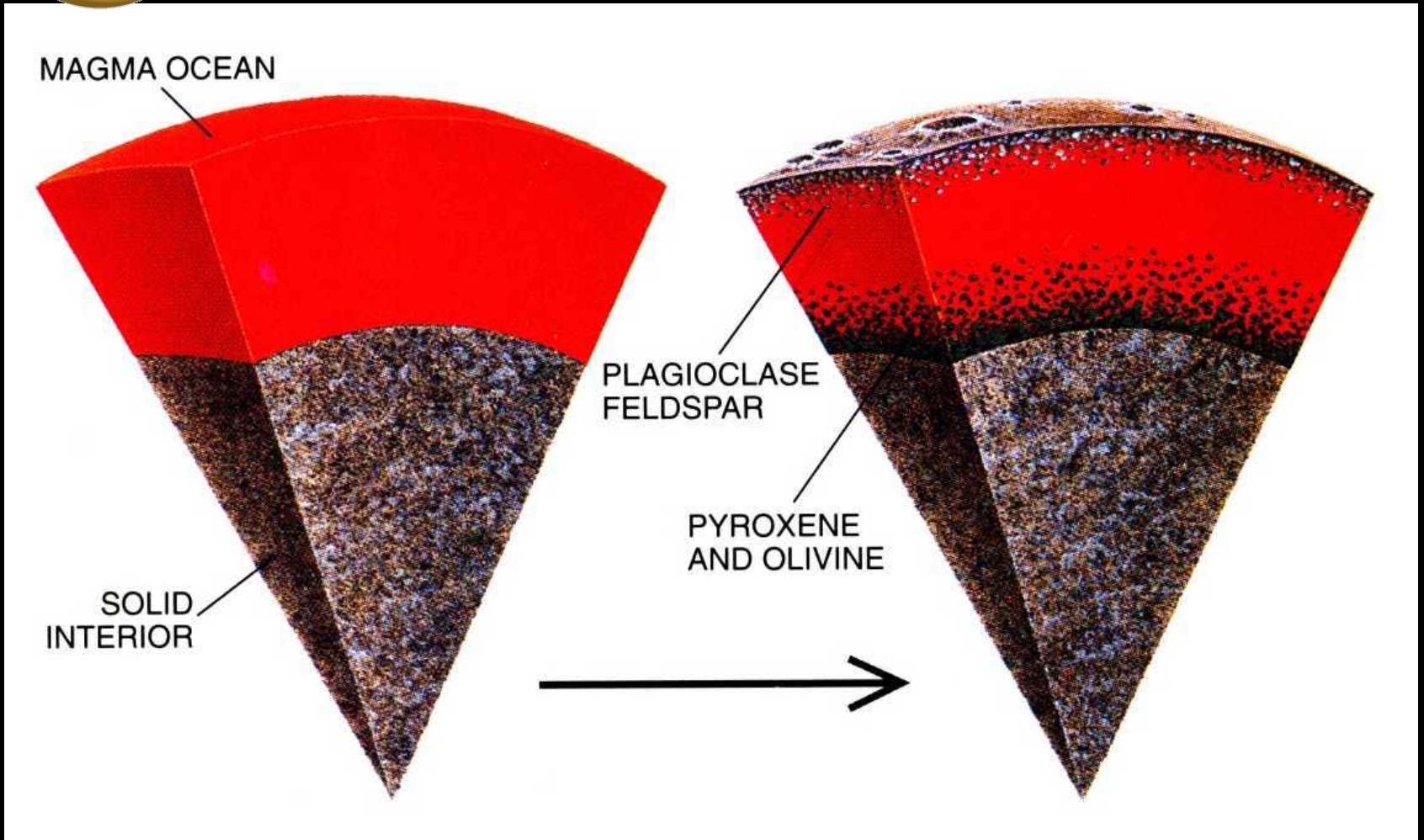
Lunar Geologic History

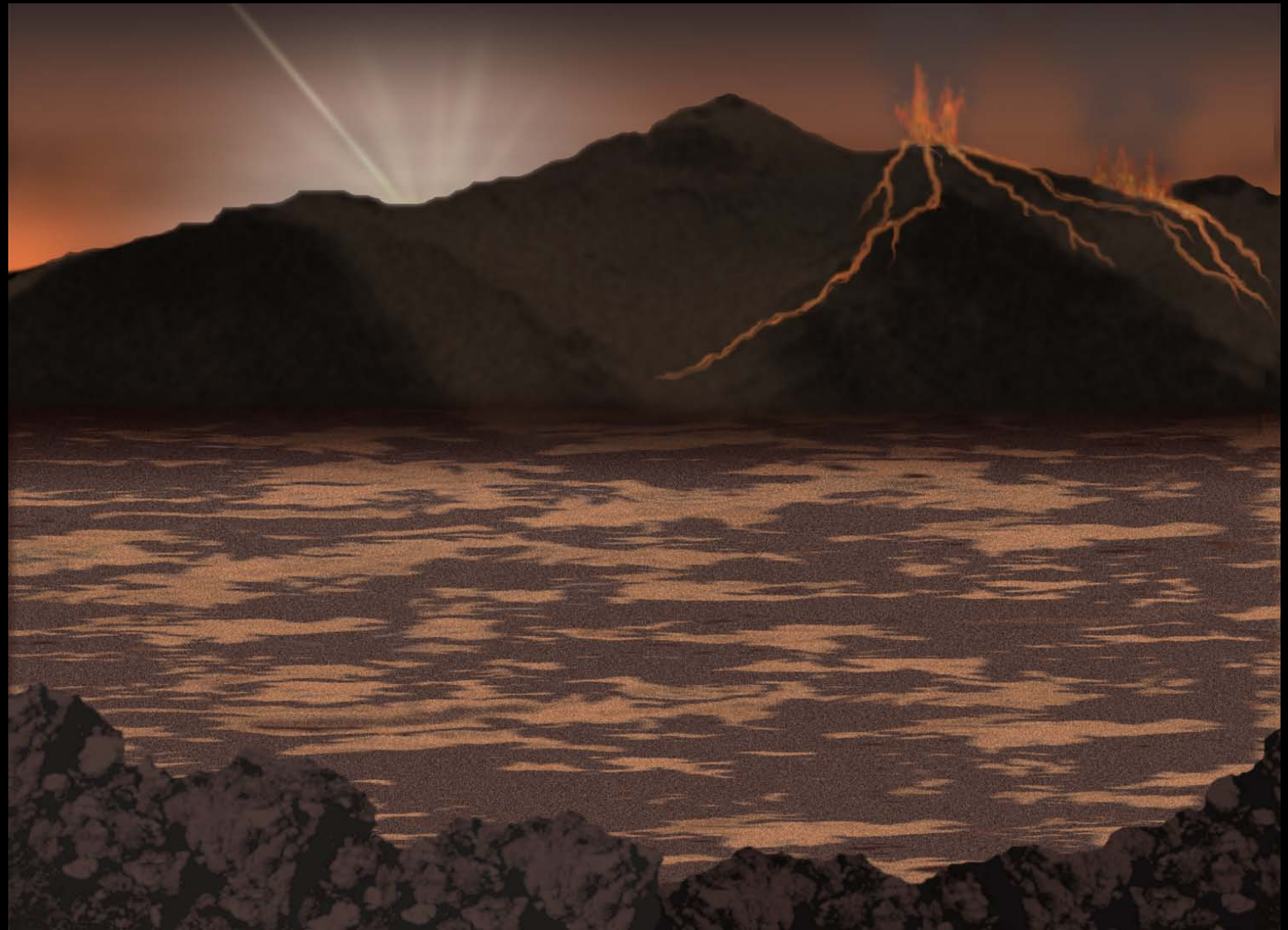


4.5 billion years ago, our Moon forms
(lunar rocks and meteorites)



The Magma Ocean





Magma Ocean Rocks



60025
Anorthosite
4.44-4.51 Ga

76535
Troctolite
4.2-4.3 Ga



Lunar Geologic History

Highlands - light, rough
(Terrae)

Mostly anorthosite
(plagioclase feldspars -
lots of calcium and
aluminum)

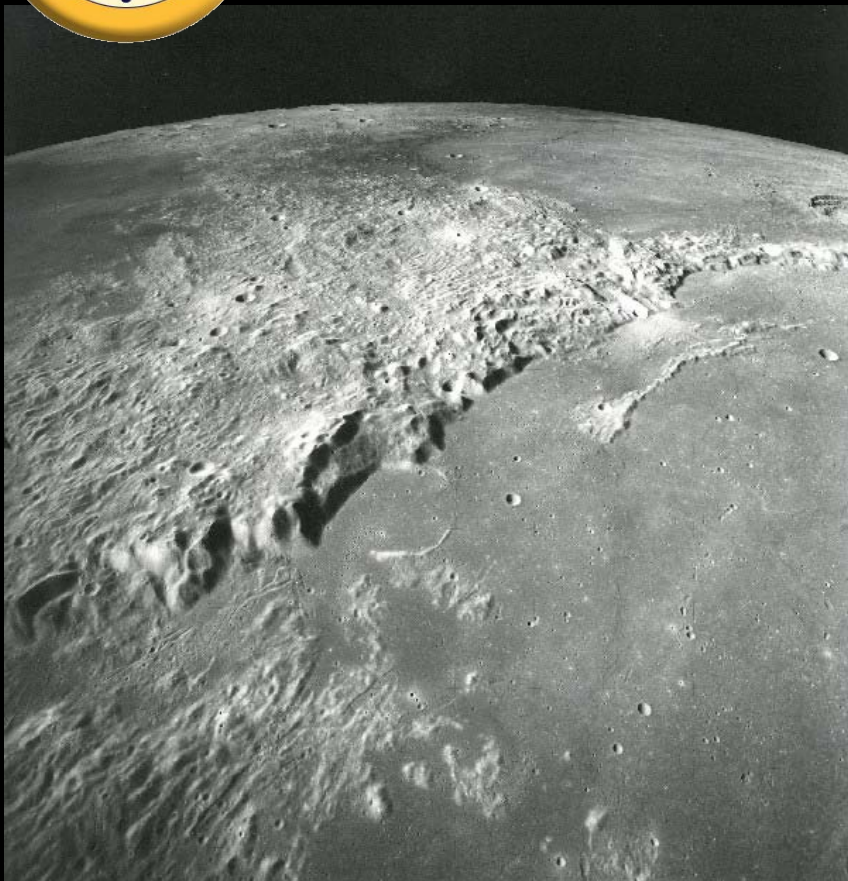
“In place” rocks are 4.5
to 4.3 billion years old

BIG Dark areas?

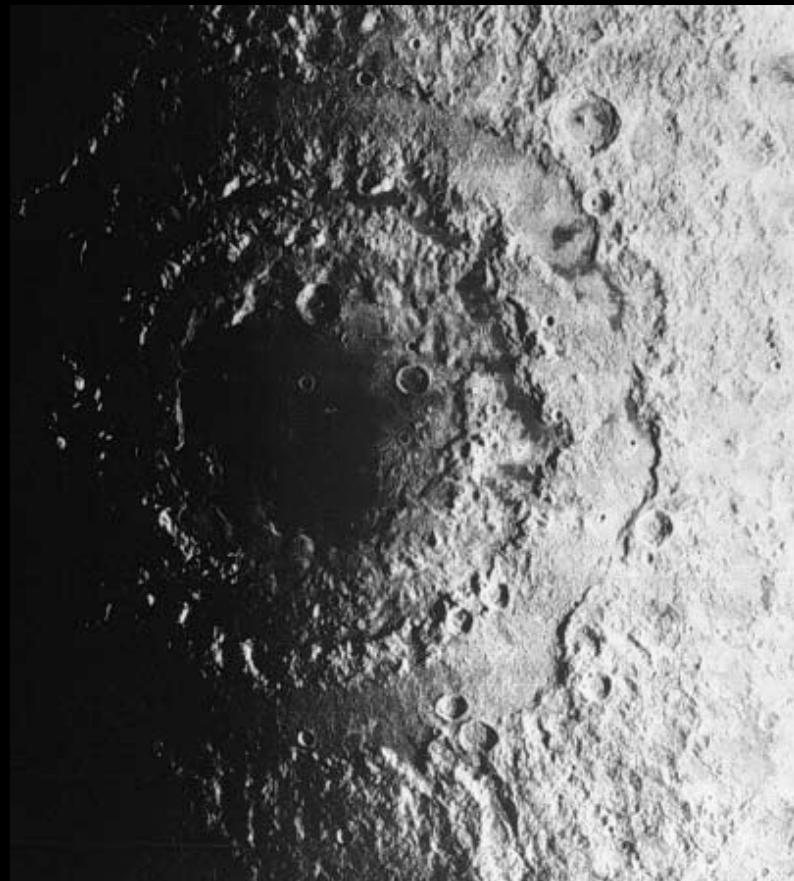




Lunar Impact *Basins*

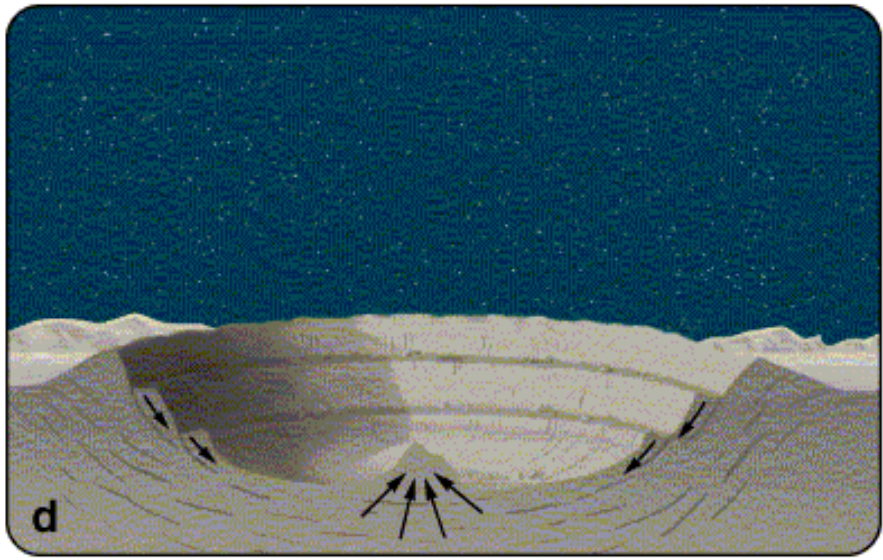
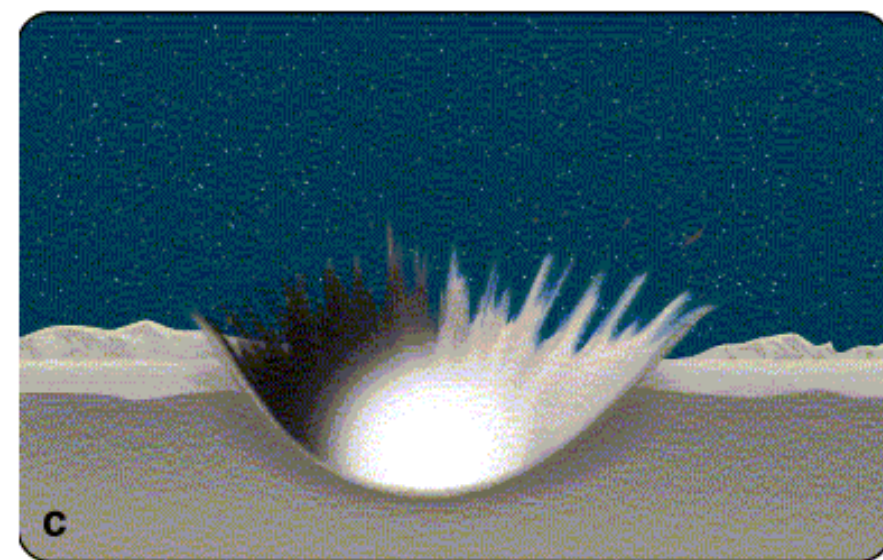
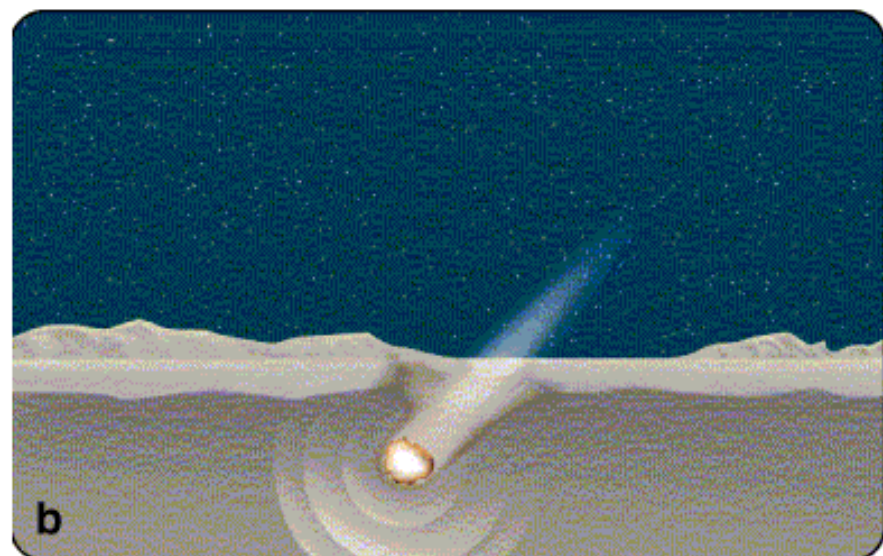
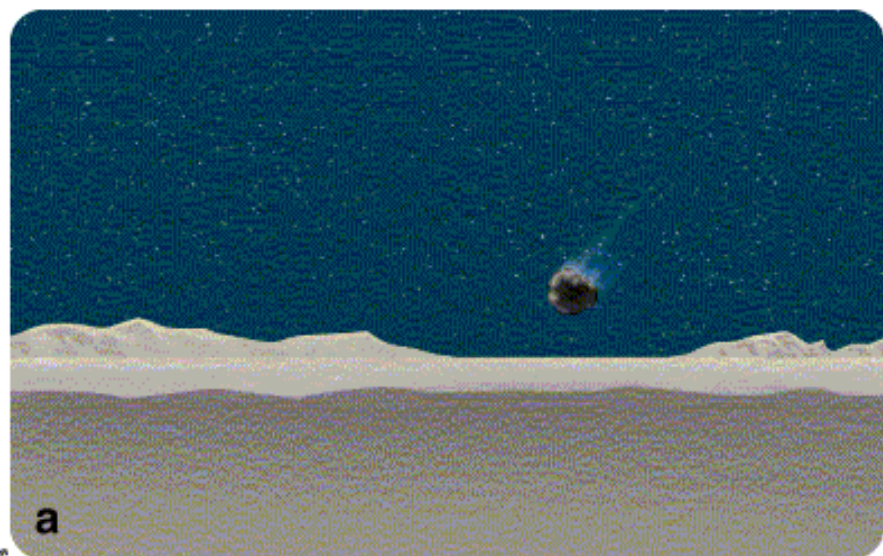


Imbrium Rim



Orientale Basin

Big, frequent impacts until 3.8 billion years ago
Impact events continue on all moons and planets today



Rays

Ejecta

Floor

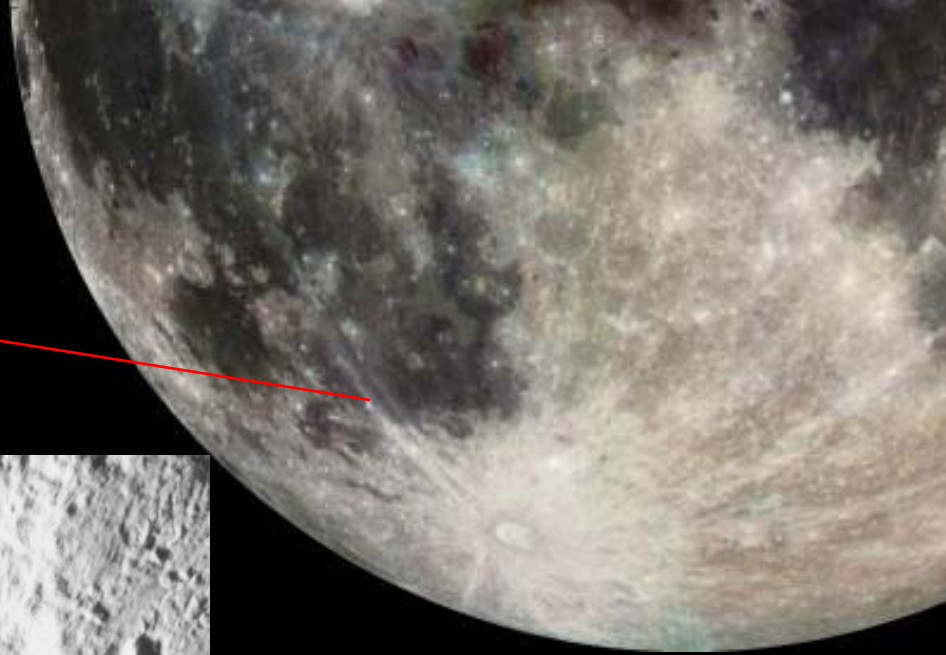
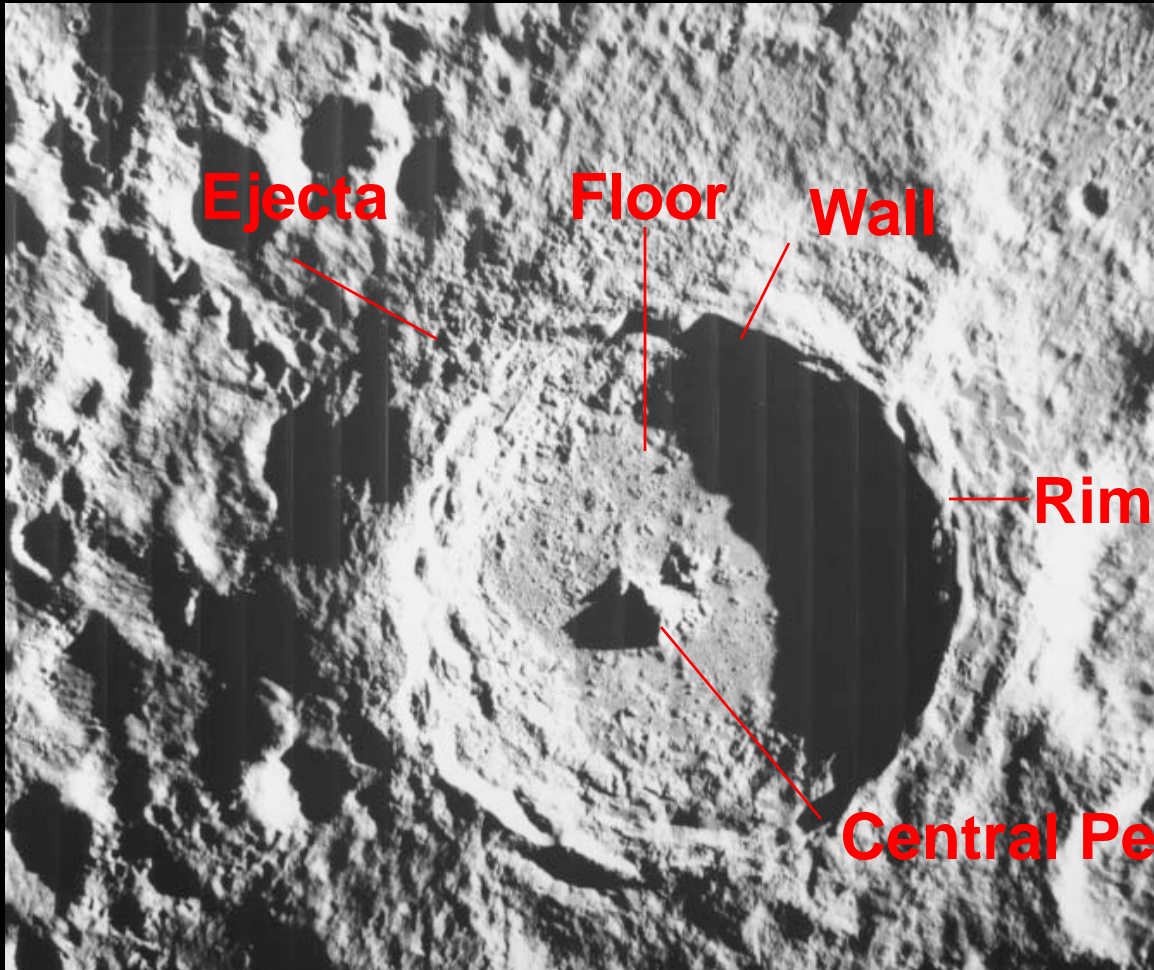
Wall

Rim

Central Peak

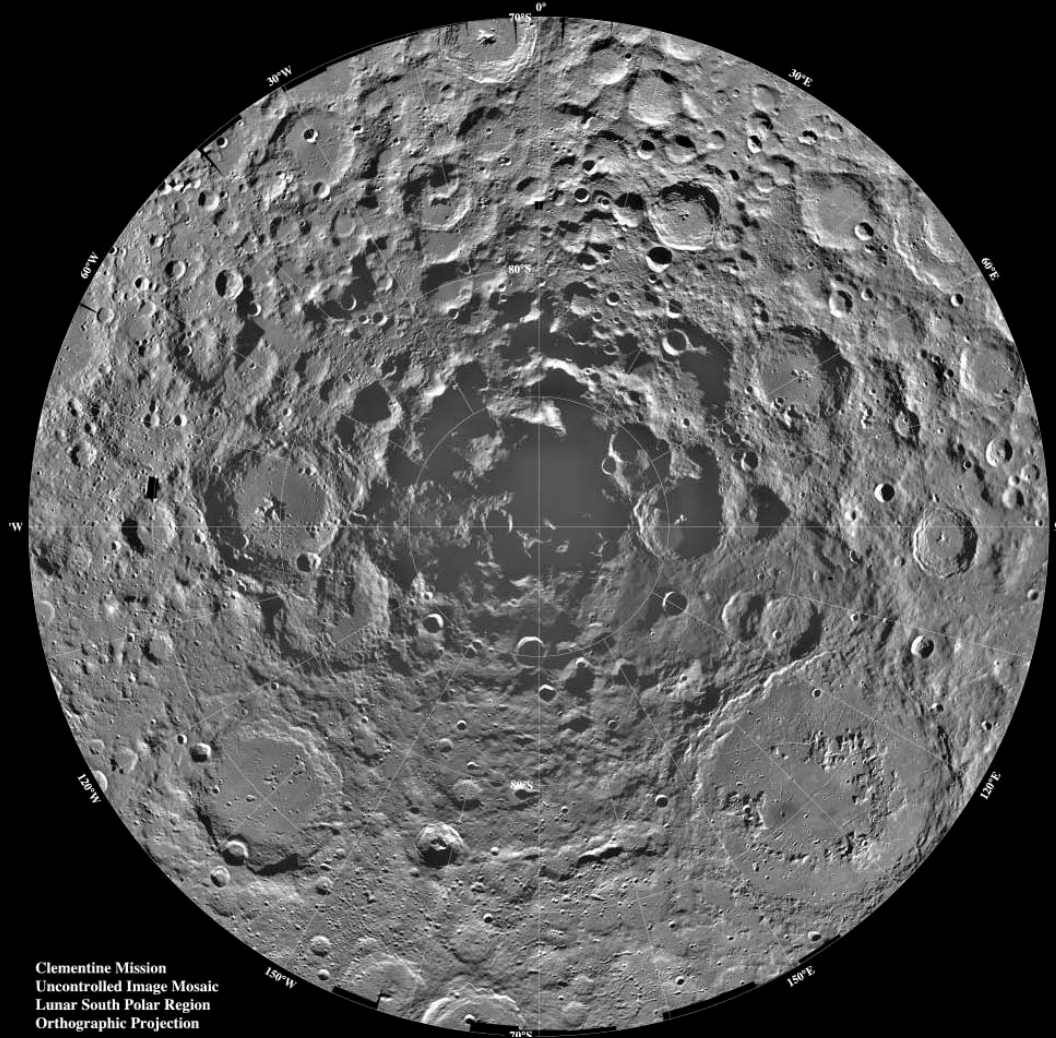
Tycho Crater

Young – 1 billion
85 kilometers across
Fresh (rays) = young



Impacts ... "the most fundamental process on the terrestrial planets..."

Eugene and Carolyn Shoemaker



Clementine Mission
Uncontrolled Image Mosaic
Lunar South Polar Region
Orthographic Projection

Breccias and Impact Melts



67016
Polymict Breccia

15445
Impact melt + clasts





Lunar Geologic History

Mare Volcanism

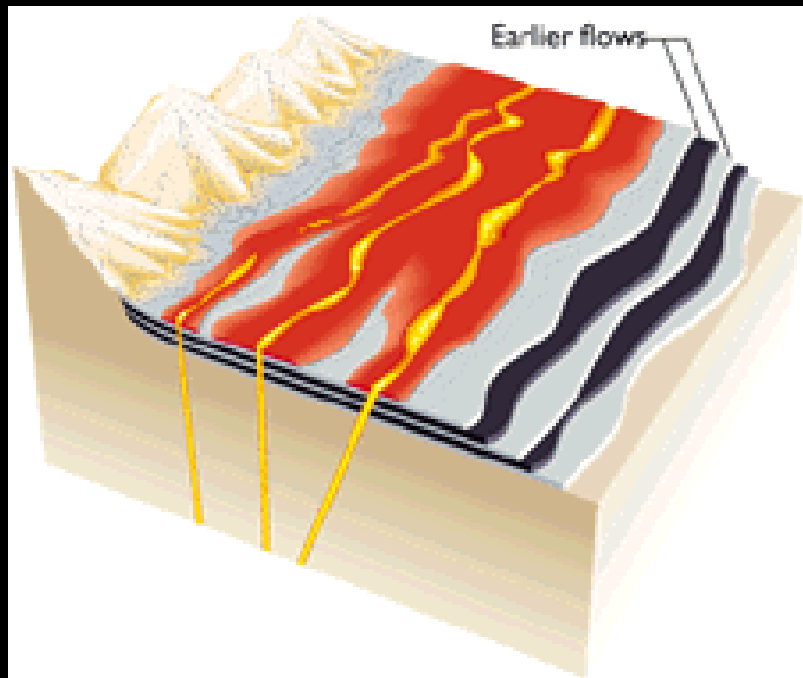


Mare Imbrium



SW Mare Imbrium

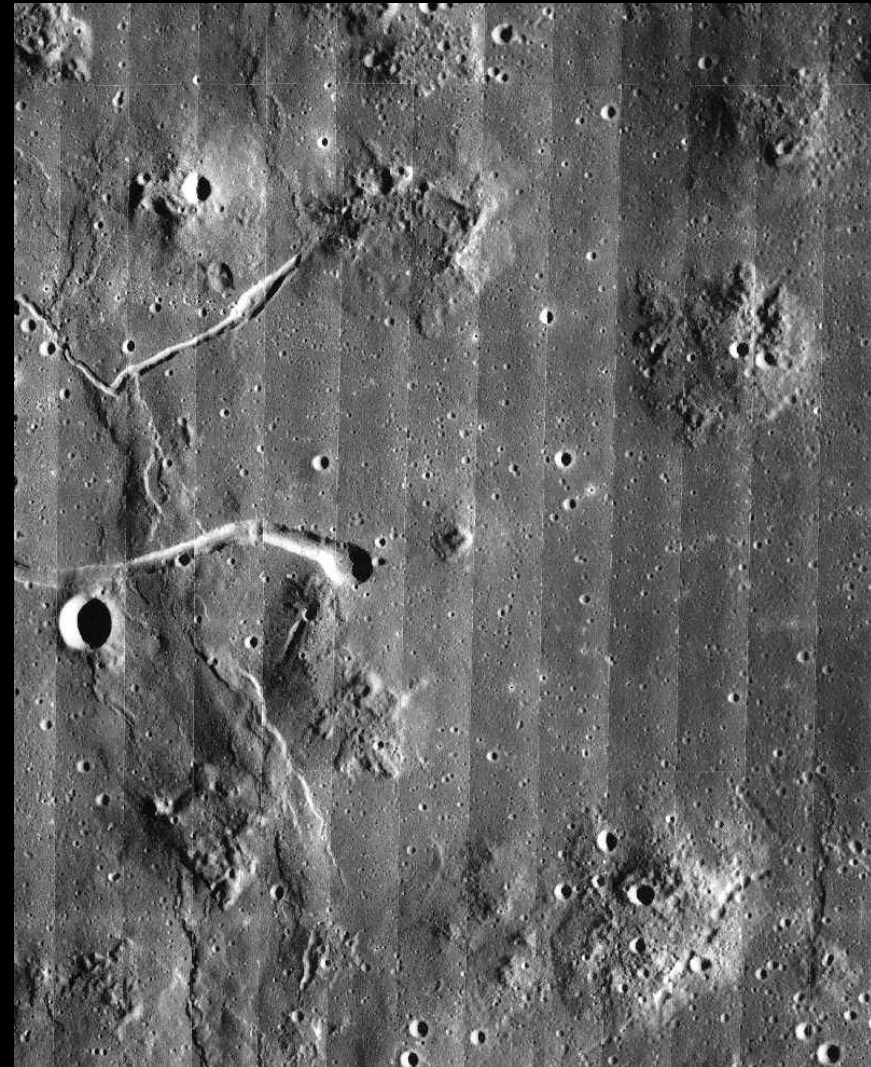
Volcanism *after* impacts – most before 3 (to 1) billion years ago



Lunar Volcanism



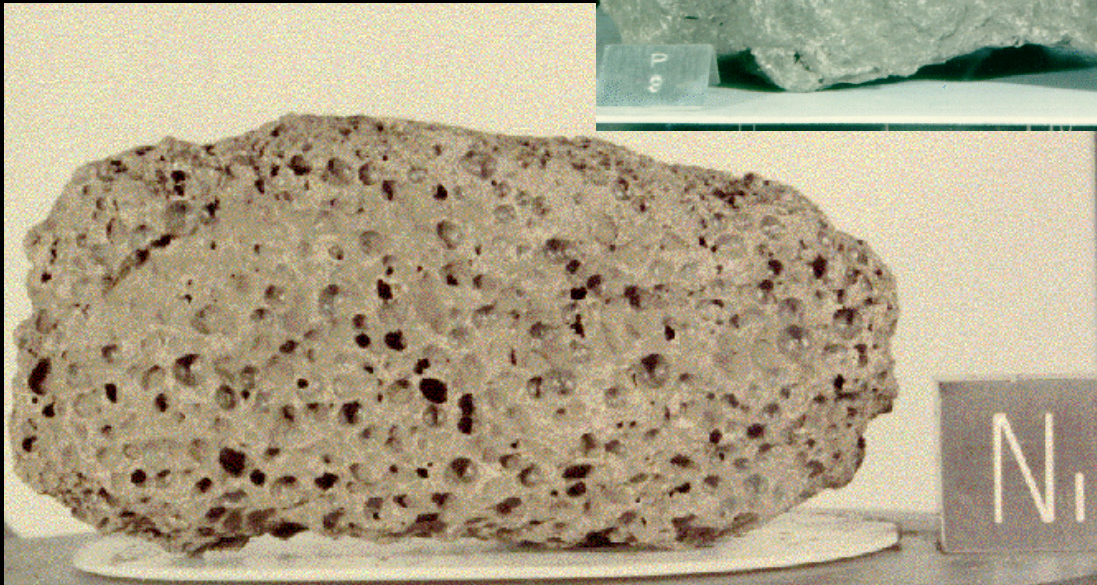
Aristarchus
Plateau



Marius Hills

Lunar Basalts

15555



3.3 Ga

15016

Lunar Geologic History



Lowlands – dark, smooth
Maria (16%)

Basalt – fine grained dark
igneous rock rich in iron
and magnesium (stuff
that sank in magma
ocean)

Few hundred meters thick

Rocks are 4.3 to 3.1 billion
years old ... flows as
recently as 1 billion years
ago



Earth



Active volcanoes

Earthquakes

Active magnetic field

Few craters

Geologically Active!

Moon



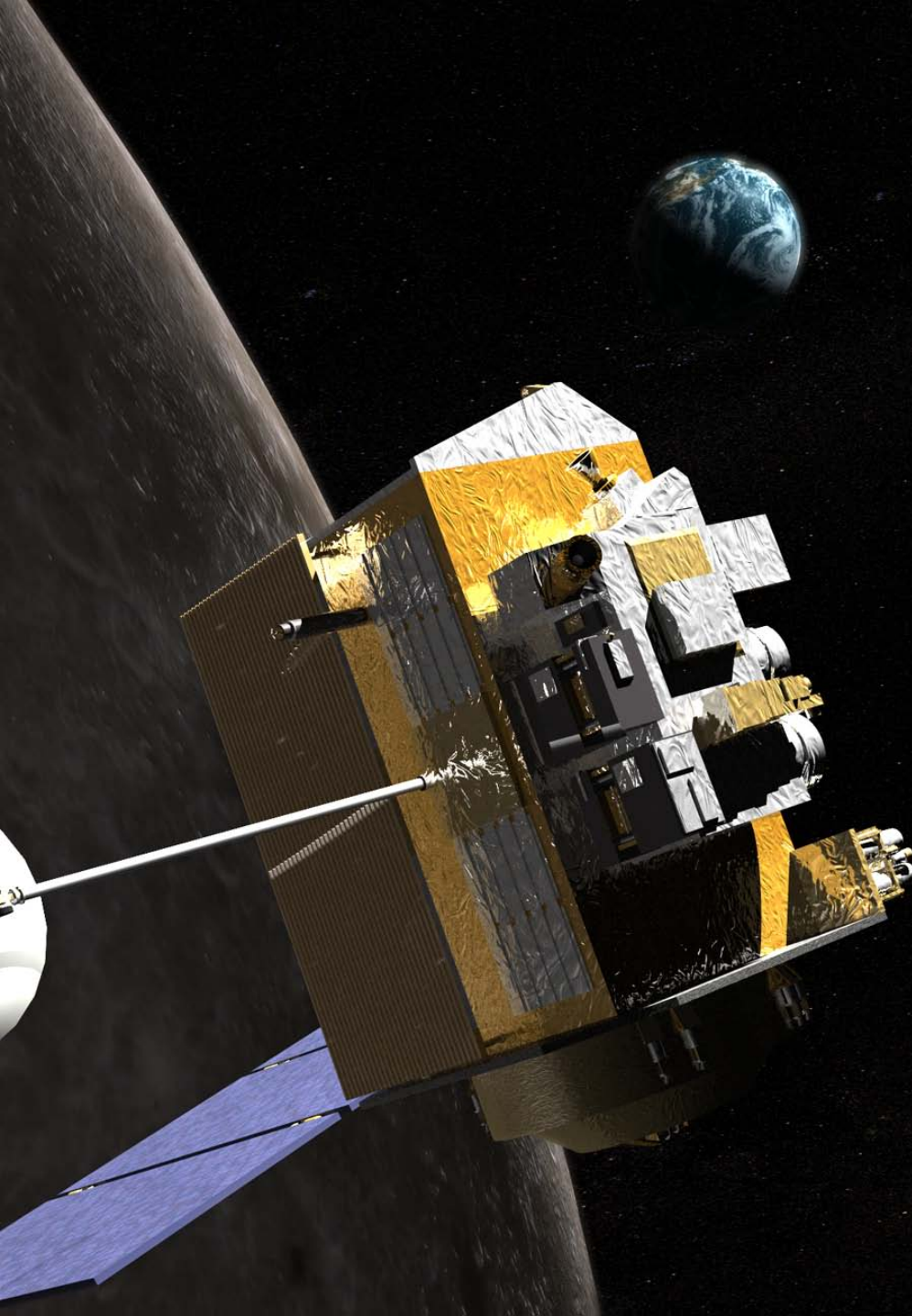
NO active volcanoes

Small moonquakes

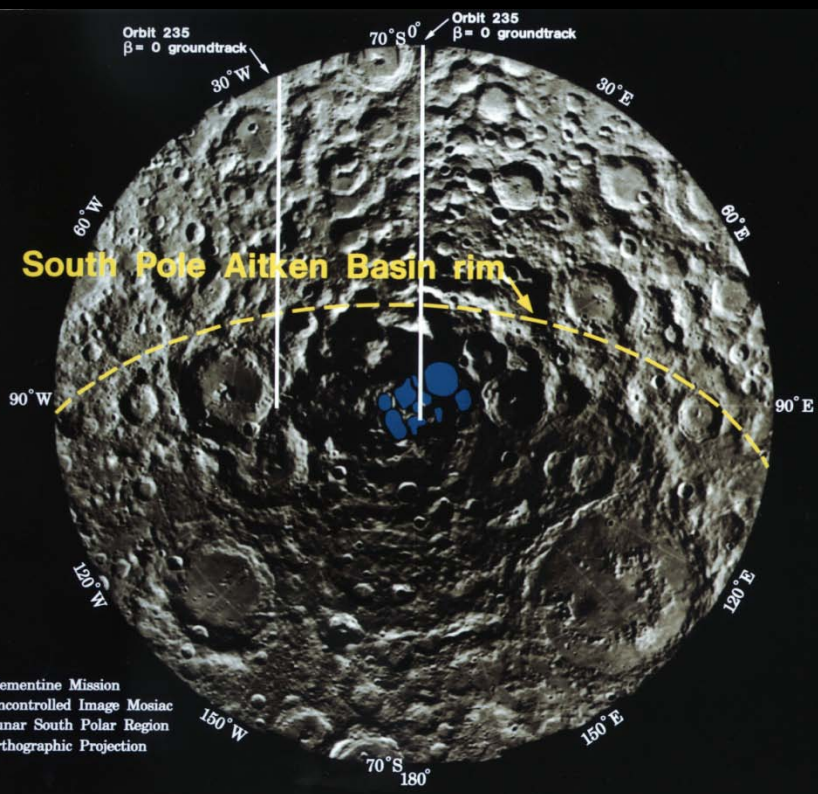
NO active magnetic field

Buckets of craters

Geologically Inactive!

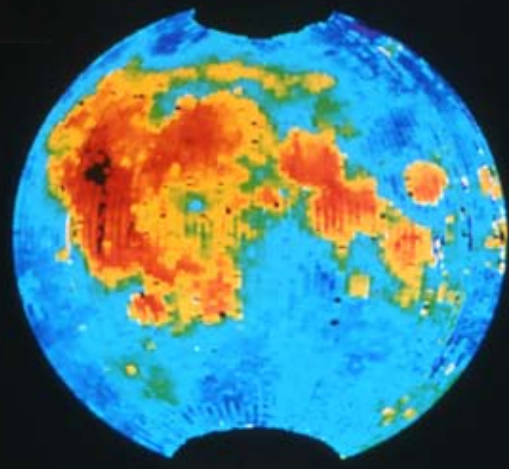


LRO – 2008 !

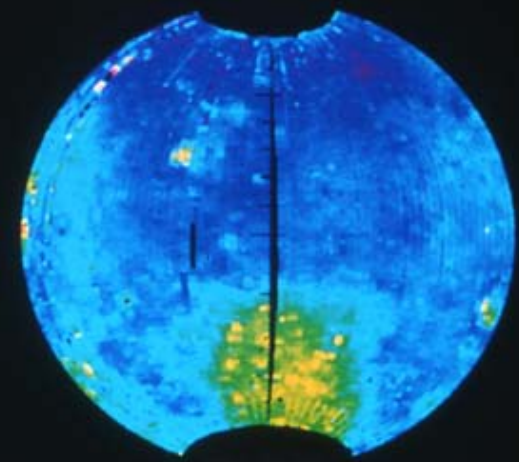


Clementine Mission
 Uncontrolled Image Mosaic
 Lunar South Polar Region
 Orthographic Projection

Clementine Iron Map of the Moon Equal Area Projection



Near Side



Far Side

