



BELL RINGER

1. WHAT IS UNIQUE ABOUT THE ORBITAL PERIOD (YEAR) AND ROTATIONAL PERIOD (DAY) OF MOST MOONS IN THE SOLAR SYSTEM?
2. PUT IN ORDER OF DENSITY FROM LEAST TO GREATEST: MOONS, INNER PLANETS, OUTER PLANETS
3. WHAT IS UNIQUE ABOUT THE INNER PLANETS, DIFFERENT FROM THE OUTER PLANETS? (BESIDES DENSITY).



POSTERS!



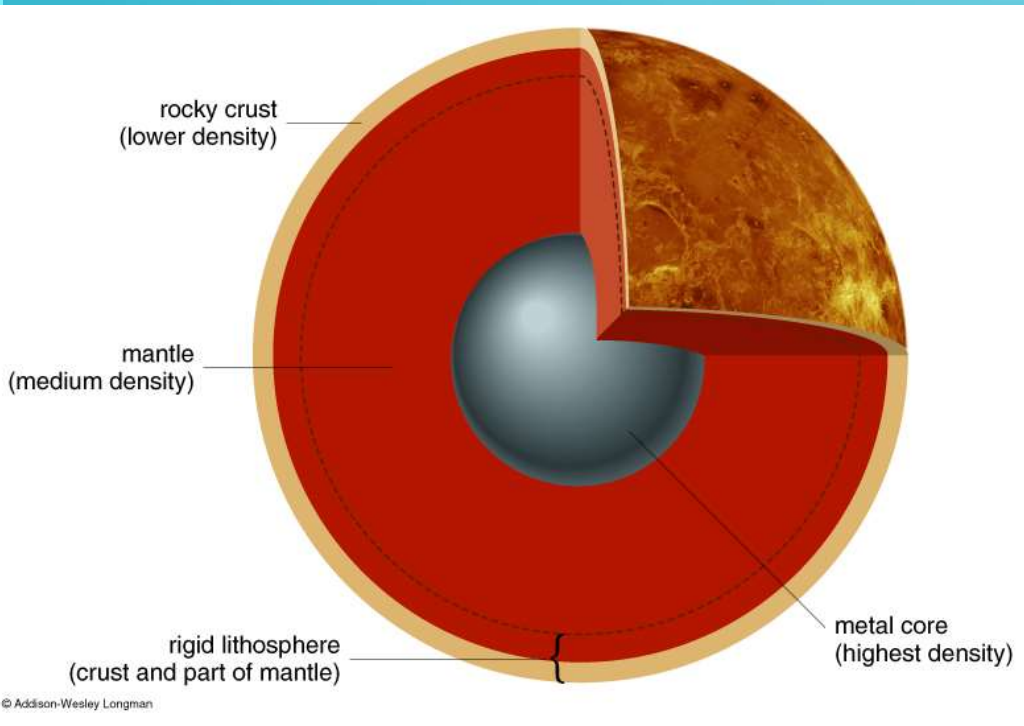
INNER PLANETS



GOALS FOR TODAY

- Understand the basic properties of all inner planets
- Understand the basic properties of each inner planet
- What makes Earth unique?

INNER PLANET INTERIORS: GENERAL FORMULA

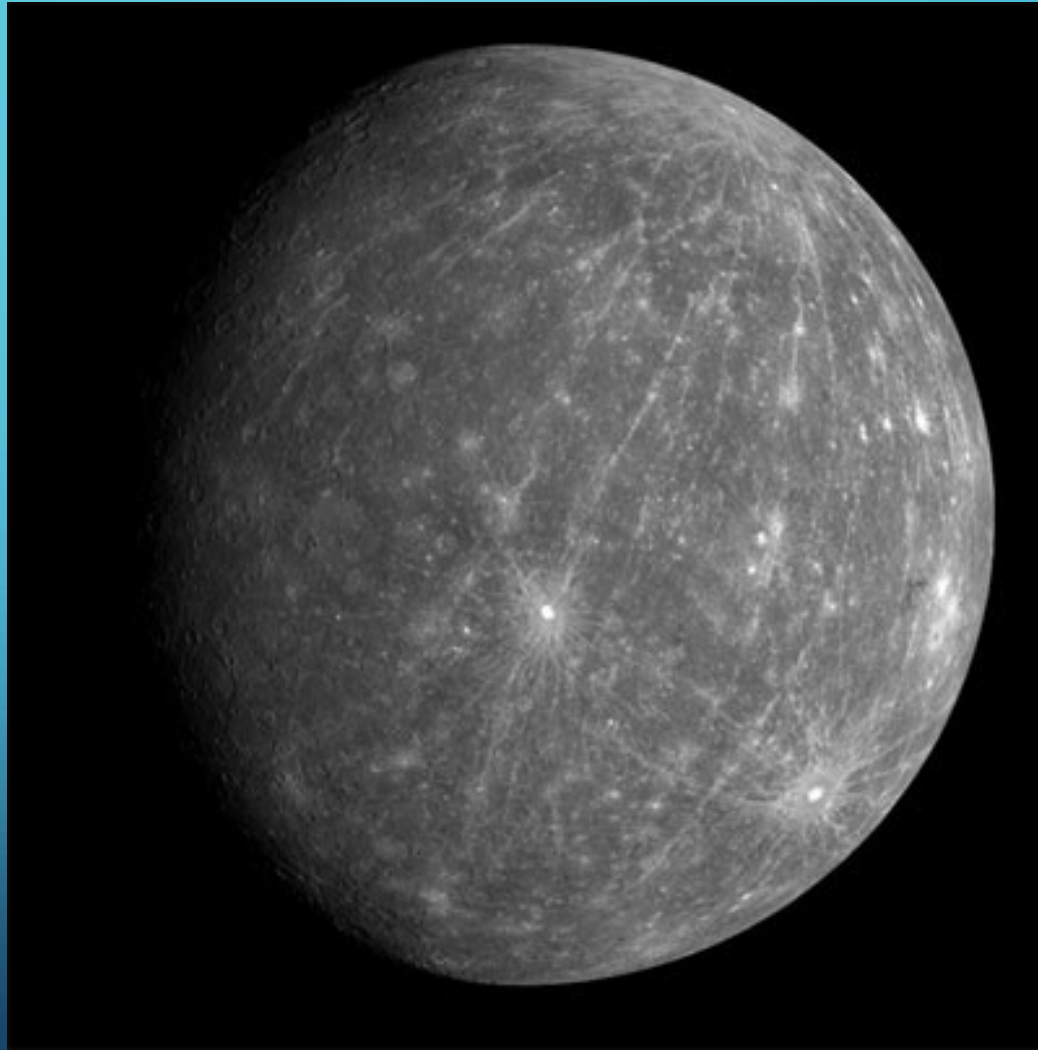


CORE: Iron metal (Really dense)

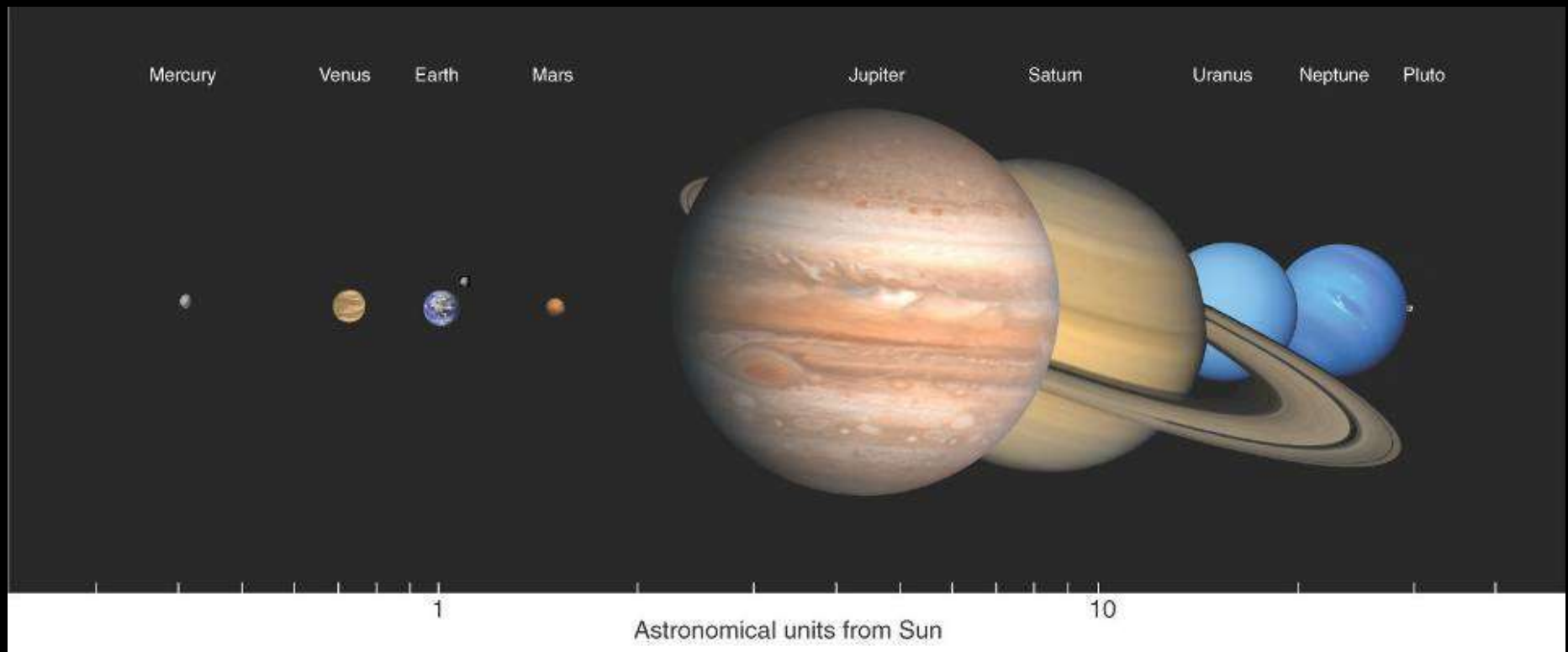
MANTLE: Rocky (Medium density)

CRUST: Rocky (Lowest density)

MERCURY



Small rocky inner planet

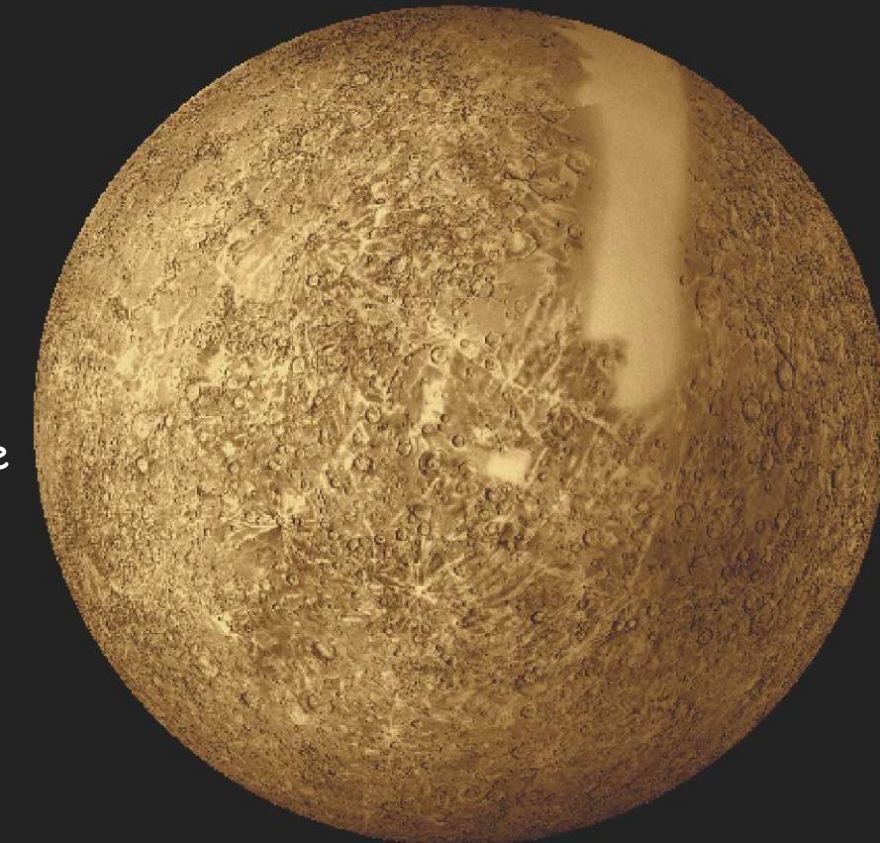




Morten van Steenwinckel (1631-1632).
The Planet Gods in the Queen's Chamber
Kronborg Castle, Denmark

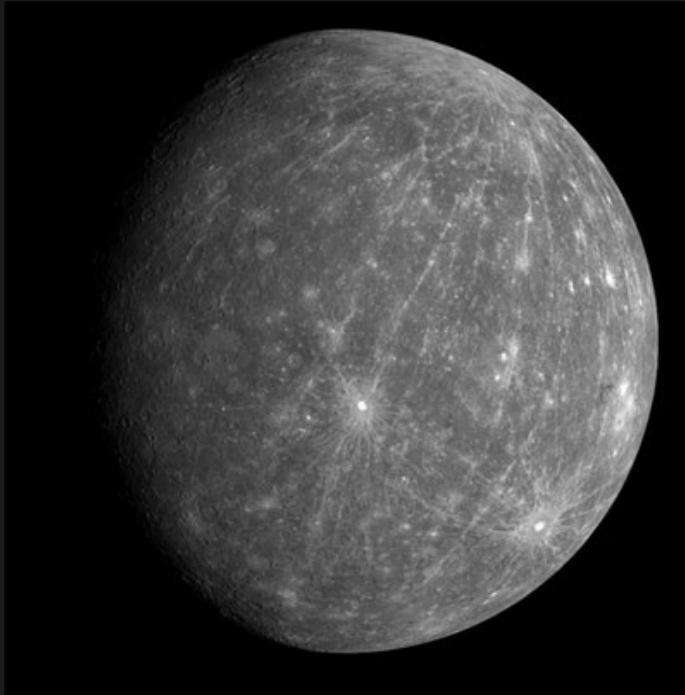
Mercury

- Roman God Mercury
- Greek Hermes
- Trade, profit, travelers--the messenger
- Winged sandals
- Winged hat
- Why Mercury?



Mercury and the Moon

What's the same? What's different?



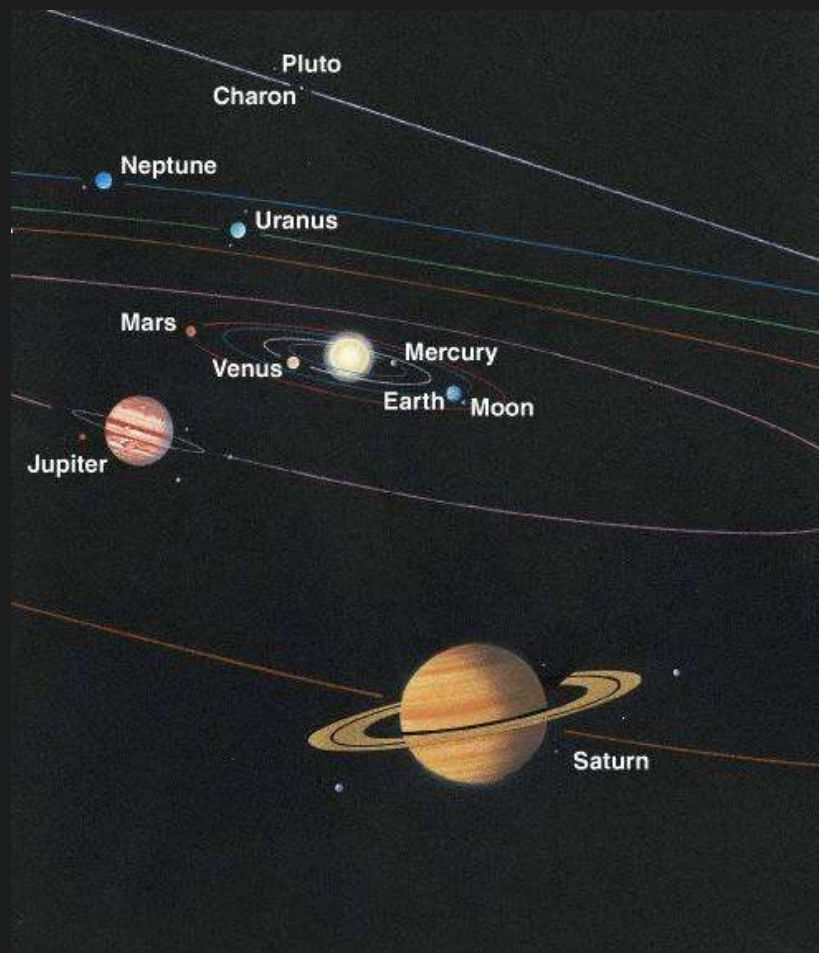
4880 km
5.4 g/cm³



3400 km
3.3 g/cm³



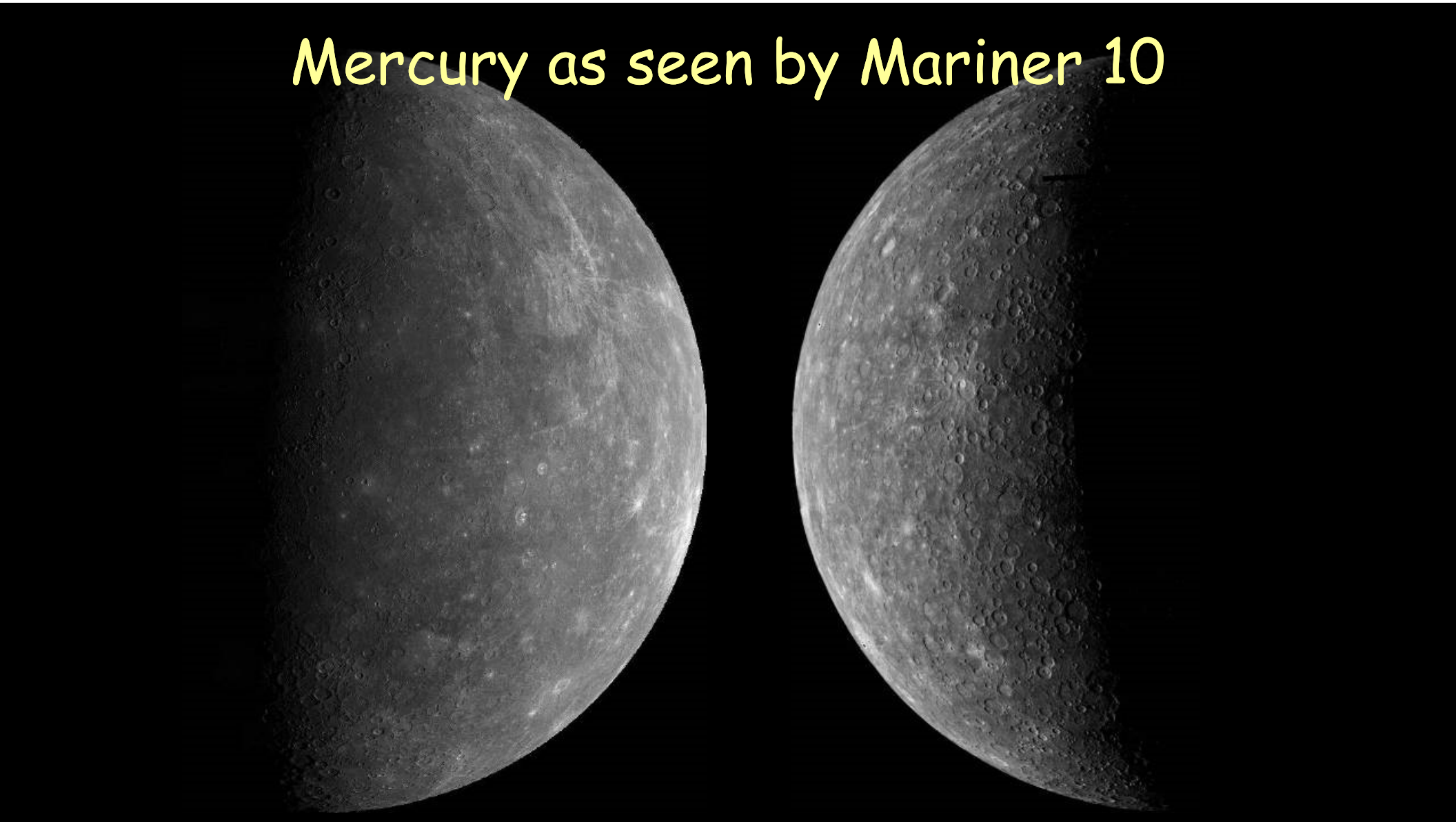
		<u>Mercury</u>	Moon	Eros
Size (km)		<u>4,880</u>	3,480	35
Density (g/cm³)		<u>5.4</u>	3.3	2.6
Year (Orbit)		<u>88</u> d	365 d	~2 y
Day (Rotation)		<u>59</u> d	28 d	5.3 h
Temp.	DAY	<u>801</u> deg	224 deg	212 deg
(Fahrenheit)	NIGHT	<u>-279</u> deg	-298 deg	-238 deg
Distance (AU)		<u>0.4</u>	1.0	1.5
Gravity (Comp. to Earth)		<u>.38</u>	.17	.001



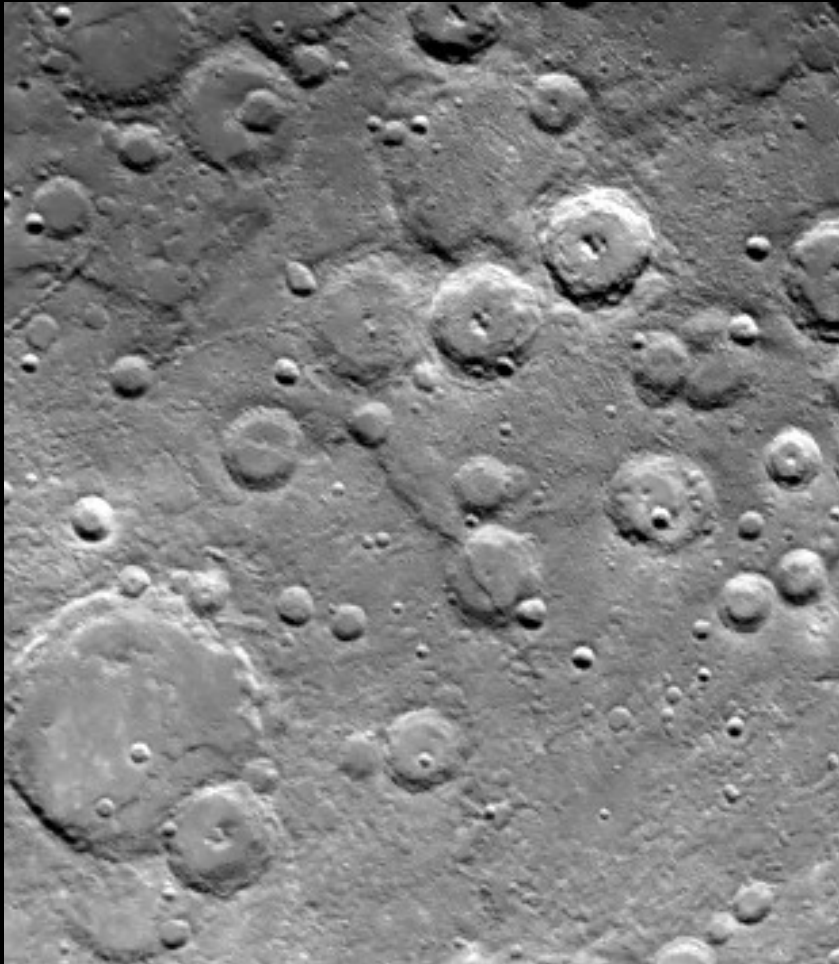
Mercury

- Innermost planet
- Visited by Mariner 10 (1974-1975) in a flyby photographic study
- Only half imaged

Mercury as seen by Mariner 10



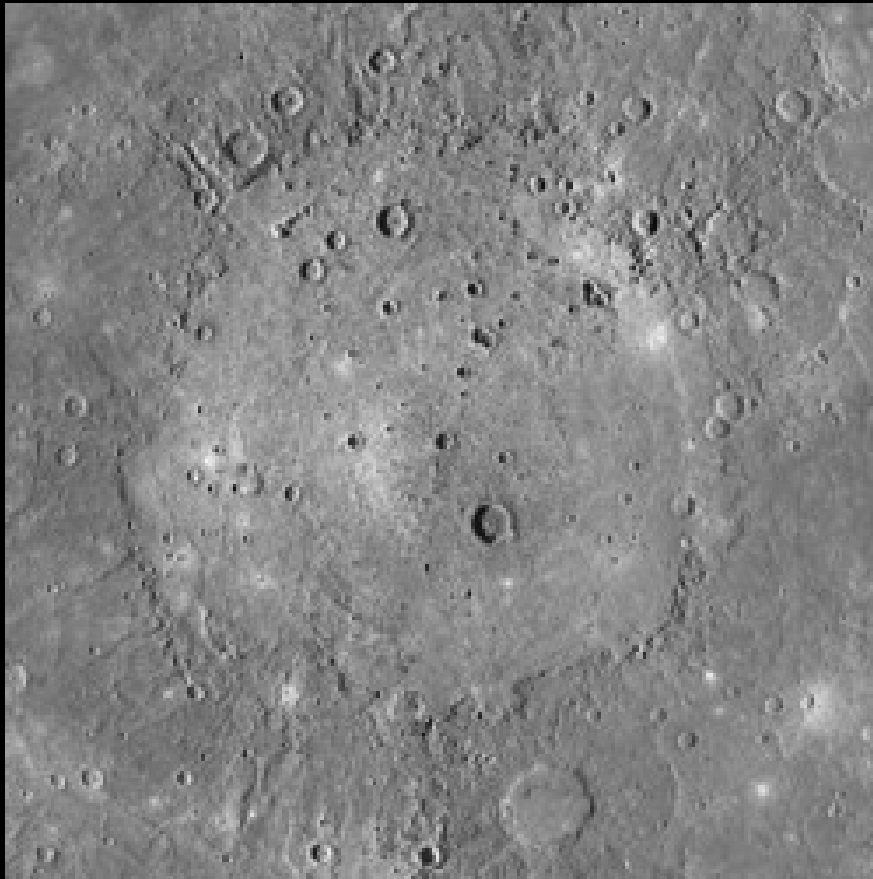
Cratered "Plains"



- Cratered plains
- Caloris
- Smooth Plains

Like the Moon!
Not as many large
impactors

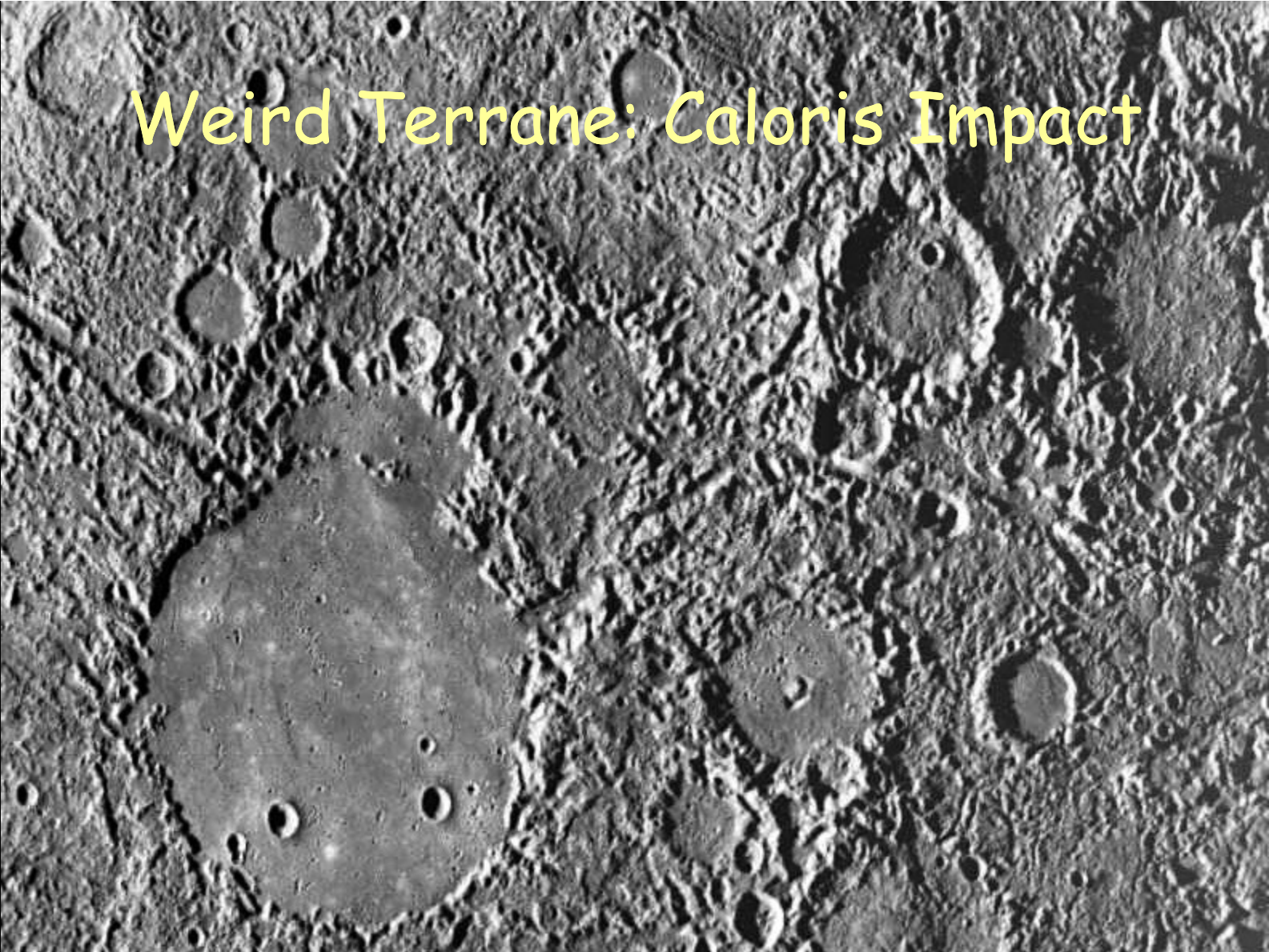
Caloris Basin



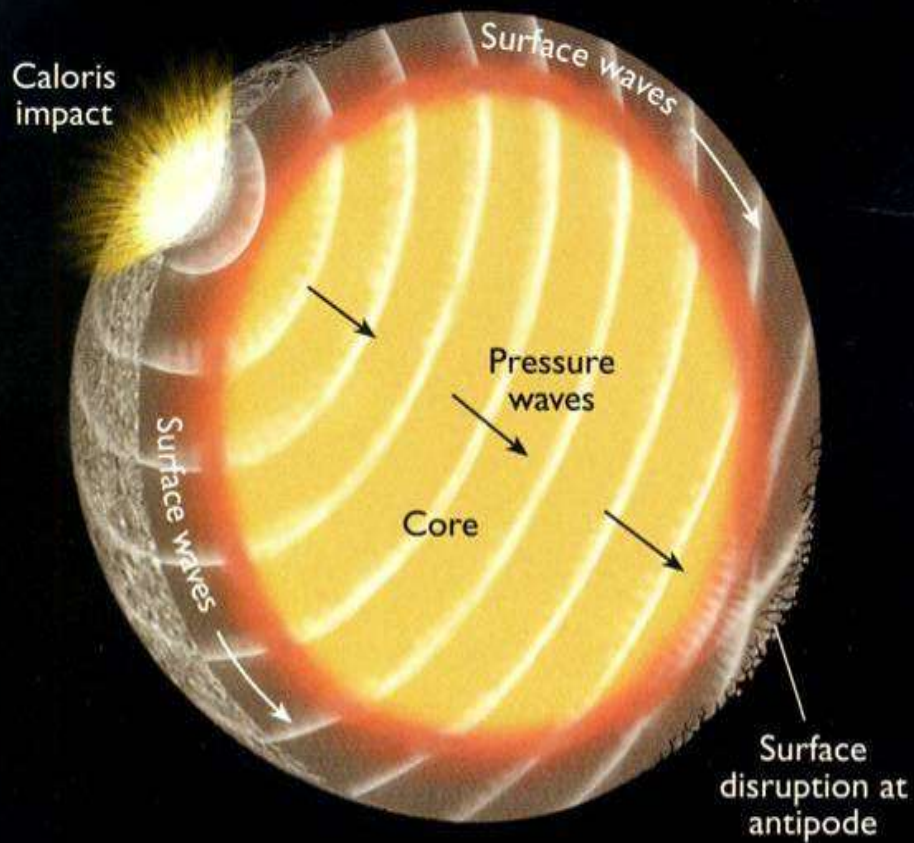
- Cratered plains
- **Caloris**
- Smooth Plains

1300 km diameter. As wide as the distance from here to Seattle.

Weird Terrane: Caloris Impact

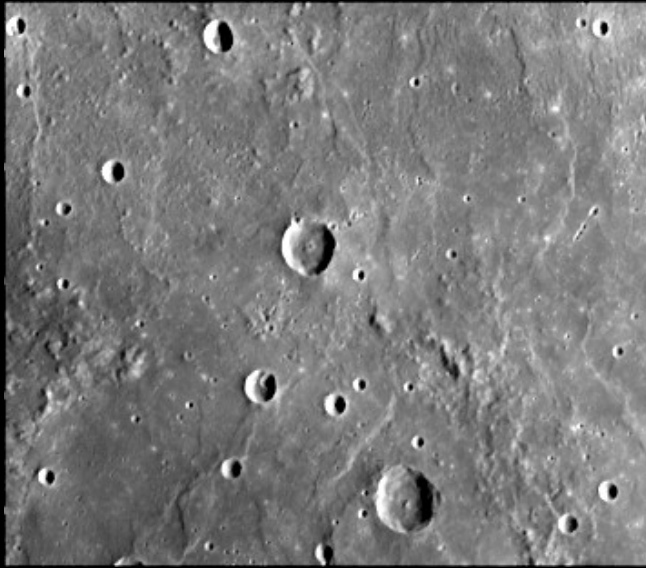


Weird Terrane: Caloris Impact

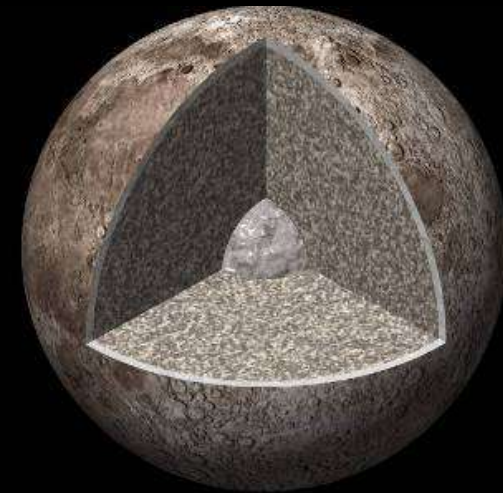
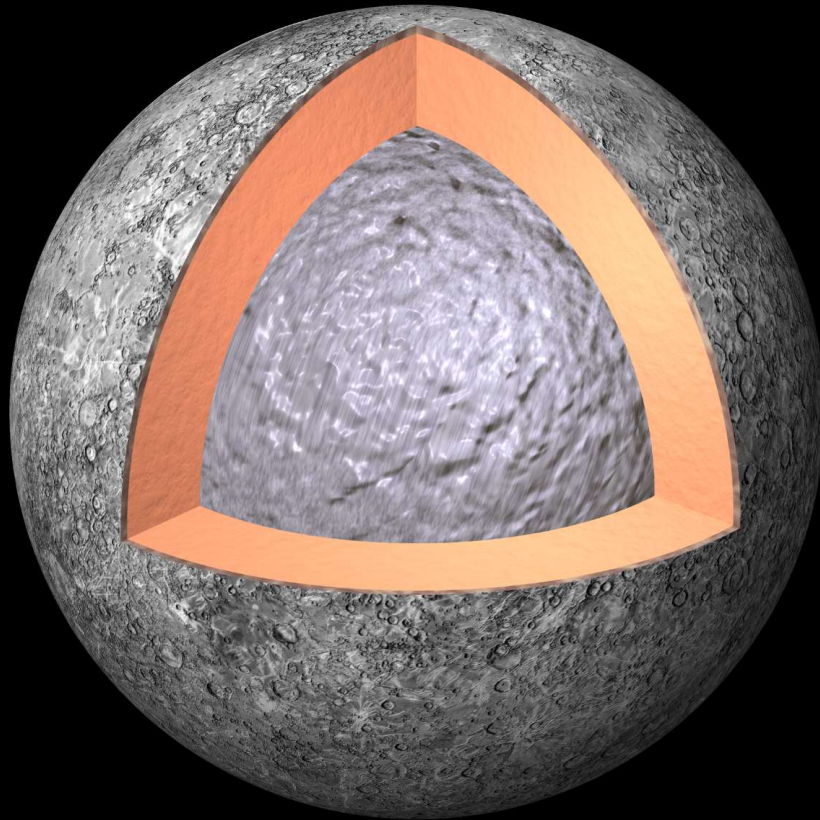


Principal Provinces

- Cratered plains
- Caloris
- **Smooth Plains**



Mercury's interior is not like the Moon's

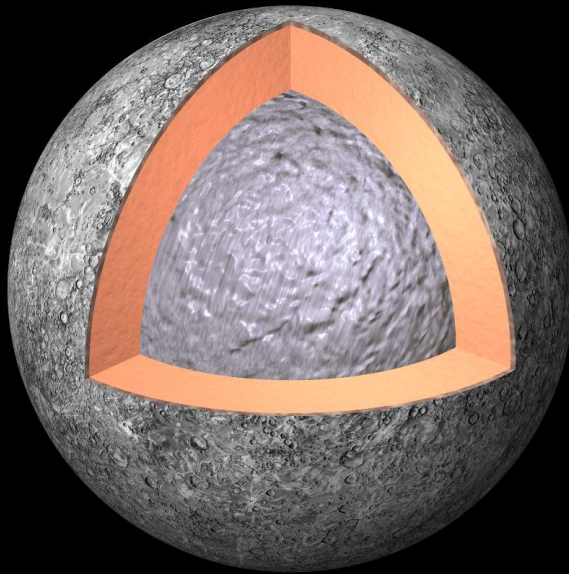


How can we tell?

Density

Huge Iron core

Why is Mercury so Iron-rich?



Interior of Mercury

© Copyright Calvin J. Hamilton

- Were the materials that condensed to form Mercury rich in iron?
- Was crust and mantle vaporized by hot Sun?
- Was ancient crust blasted away by giant impact?

60% of Mass is Iron Metal
(75% of Radius)

VENUS



Venus



- Roman Goddess of Love
- Greek Goddess Aphrodite
- Daughter of Jupiter (Zeus)
- Married to Vulcan but Lover of Mars
- Mother of Eros (Cupid)
- Emperor Julius Caesar descended from Venus

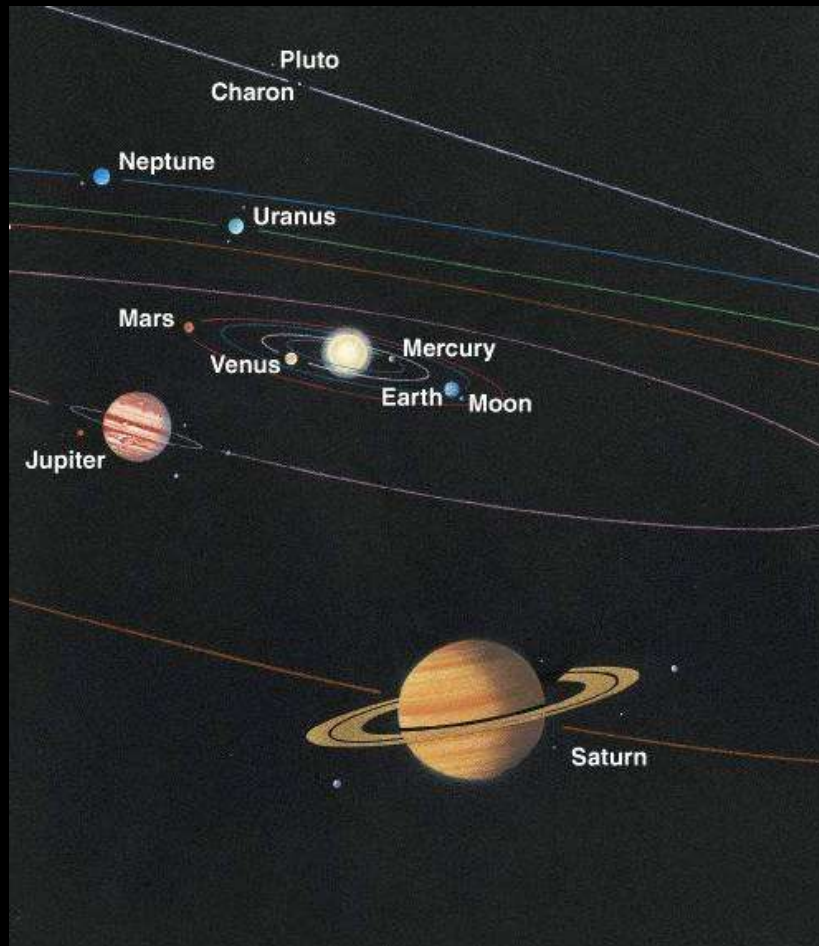


British Museum

Venus

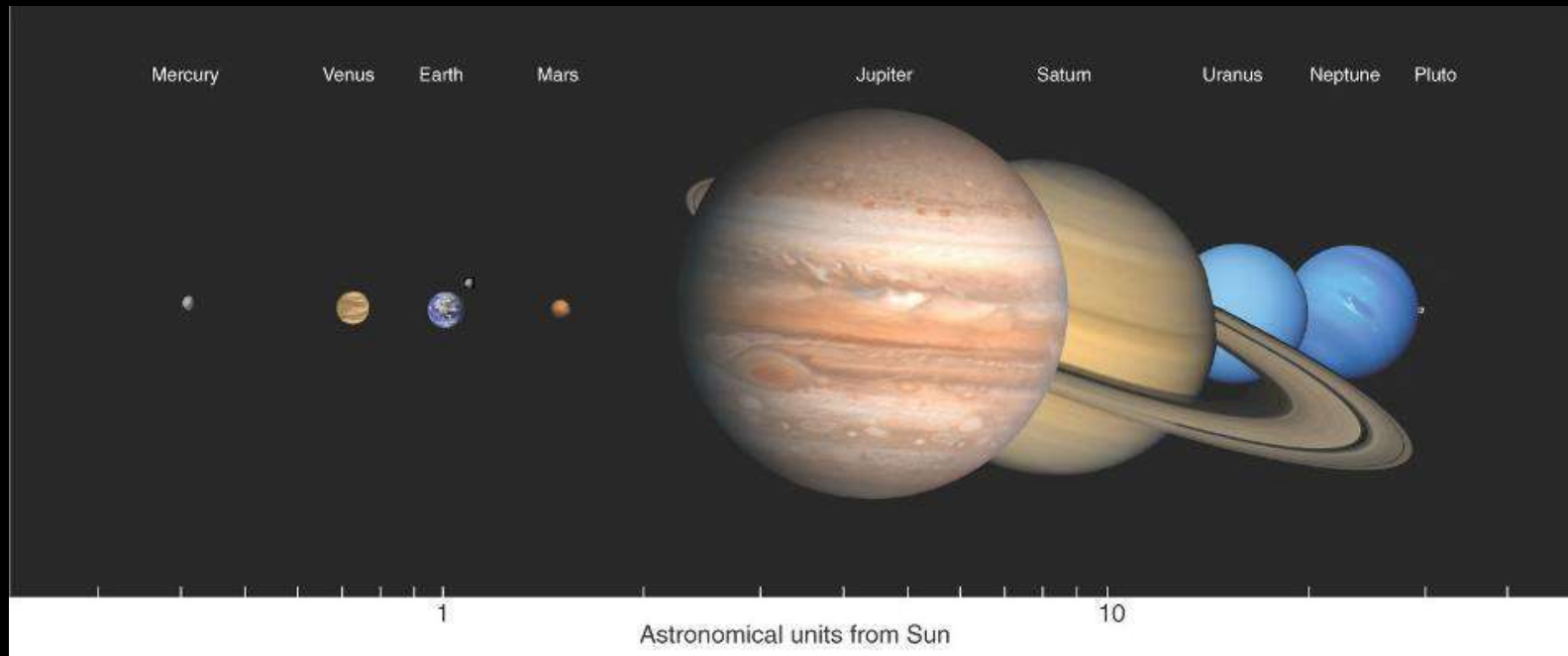


Venus with Visible and Radar Illumination © copyright 1998 by NASA & JPL/NASA



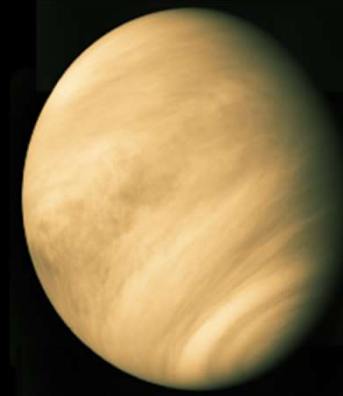
- Planet with size most like Earth
- Visited by a multitude of spacecraft
- Flybys, orbiters, and landers.
- Sample return yet to come. No known meteorites.
- We understand the topography of Venus better than Earth's oceans.

Rocky inner planet



What would you expect from its position in Solar System?

From its size?

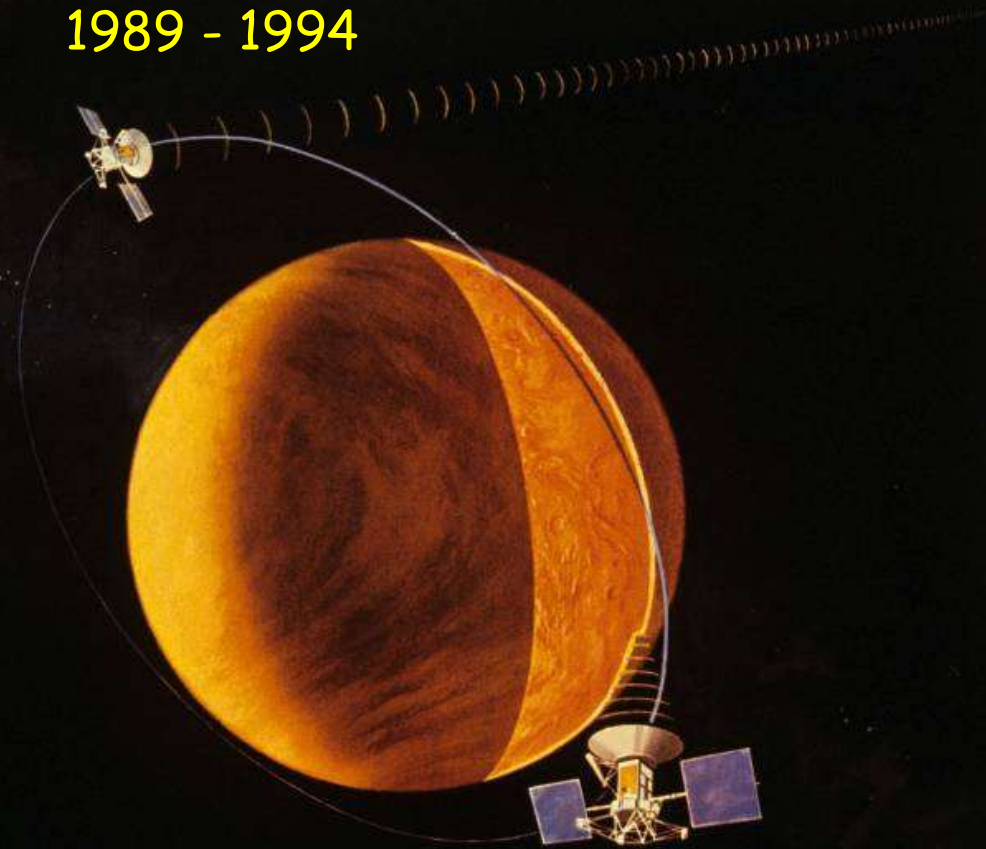


	Mars	Mercury	<u>Venus</u>
Size (km)	6,800	4,880	12,100
Density (g/cm ³)	3.93	5.4	5.2
Year	687 d	88 d	225 d
Day	24 h 37 m	59 d	243 d Retro
Temperature NIGHT (Fahrenheit) DAY	-118° -10°	-280° 800°	710° 890°
Distance (AU)	1.5	0.4	0.7
Atmos. Pres (bars)	0.1	0	100
Gravity	.38	.38	.91

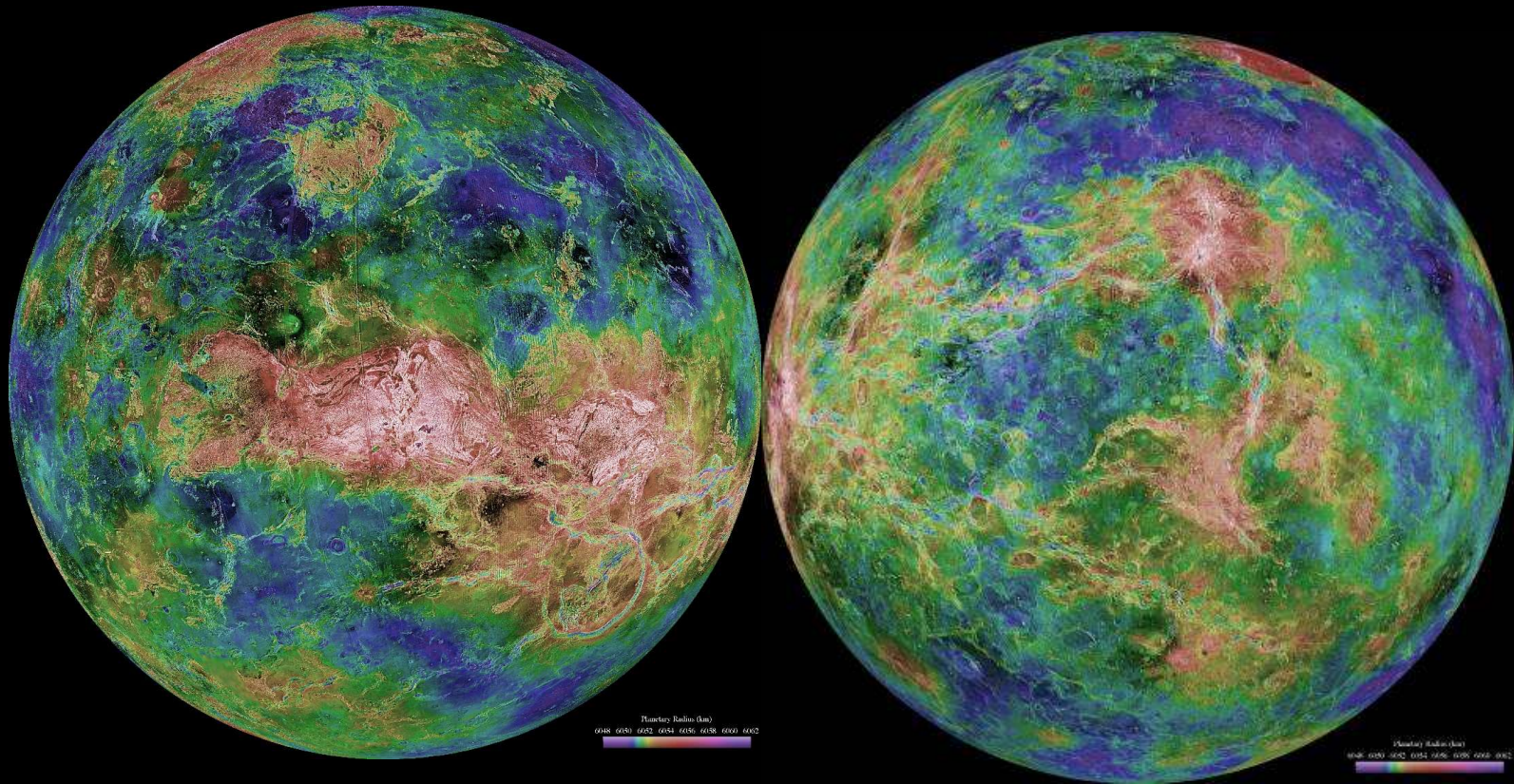
Magellan Radar Imaging

1989 - 1994

- Has to peer through the thick atmosphere
- Signal is bounced off the surface, so bright = rough, dark = smooth
- Made into a colorized altitude map.



Major Provinces of Venus: Topographic Map



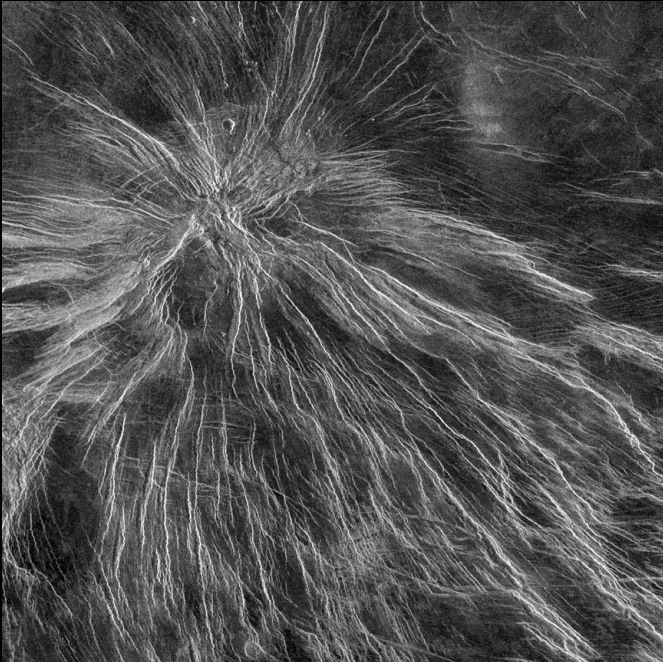
Lowlands Volcanic rises Highlands



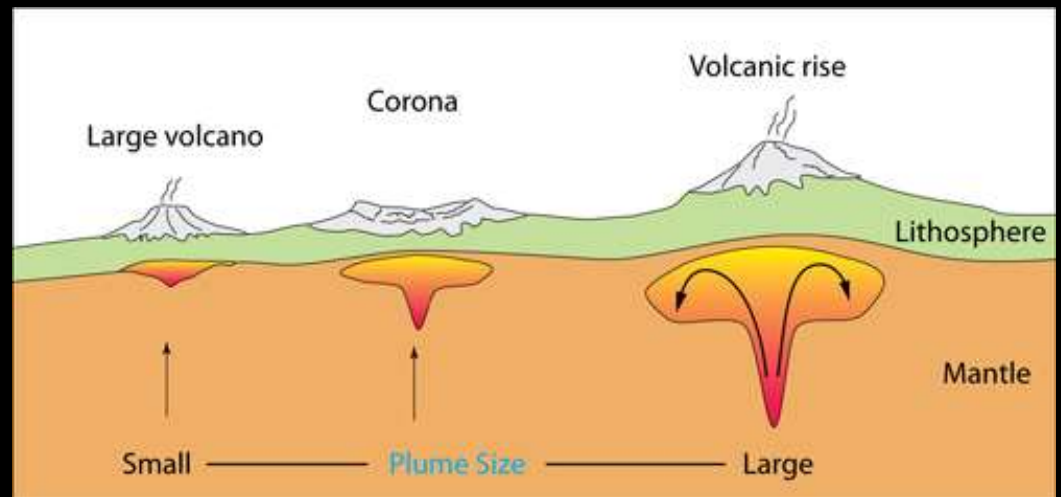
Lowlands

- Low
- Broad, relatively smooth
- Plains
- Fractures

Volcanic Rise

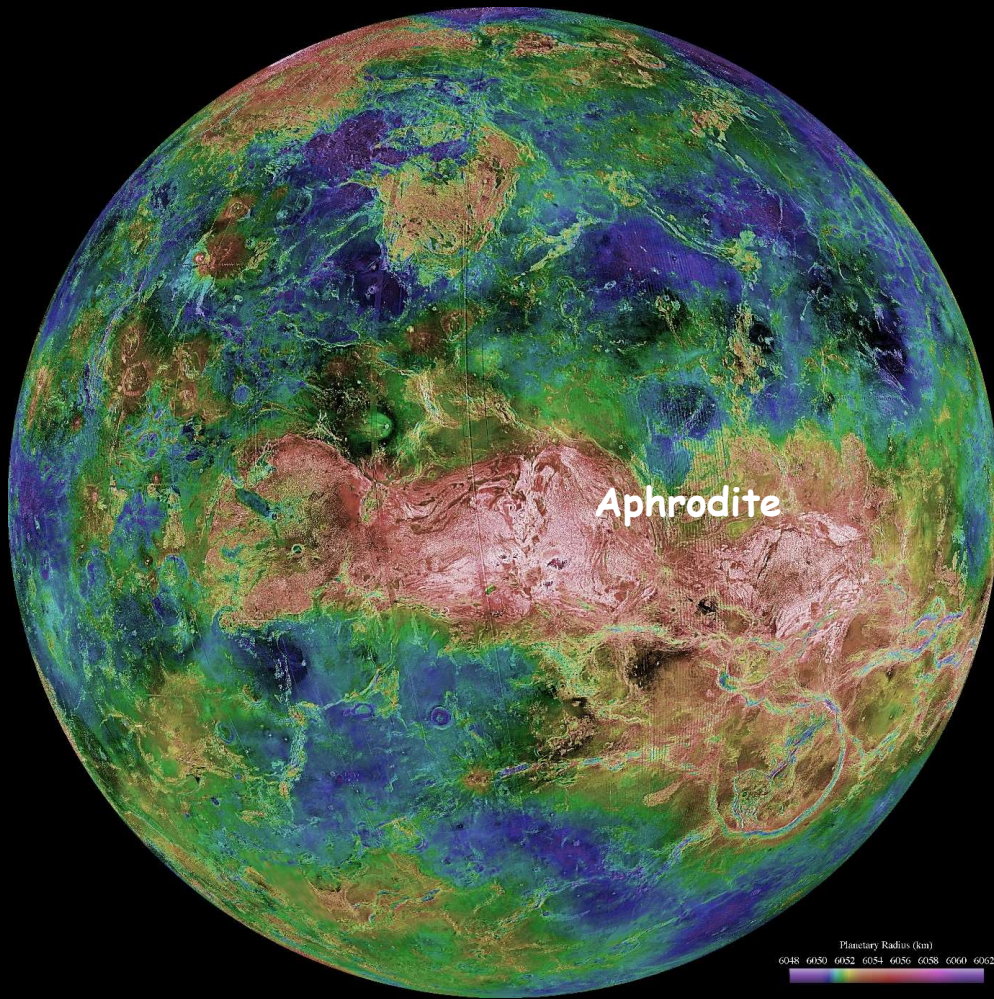


Huge dome caused
by magma pushing up
on Venus' crust.



Highlands

- Highest
- Strongly deformed
- 15% of Venus



Like, Earth, but not quite. Like
Mercury, but also not quite.
What's missing?

What was missing?

- No Impact craters
- Why?

- No Liquid water
- Why?

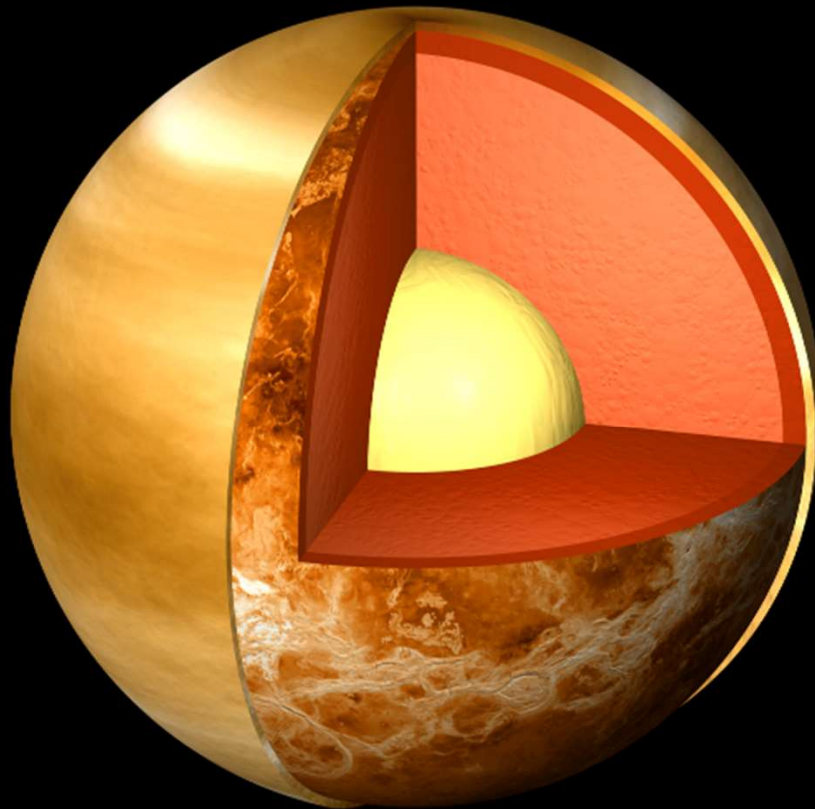
Studying Venus is hard



Russian Venus Missions

- http://www.russianspaceweb.com/spacecraft_planetary_venus.html
- Note all the failures - space exploration is hard!!

Venus oddities:



- Retrograde rotation (Sun rises in West and sets in East)
- Atmosphere 100 x thicker than Earth

EARTH





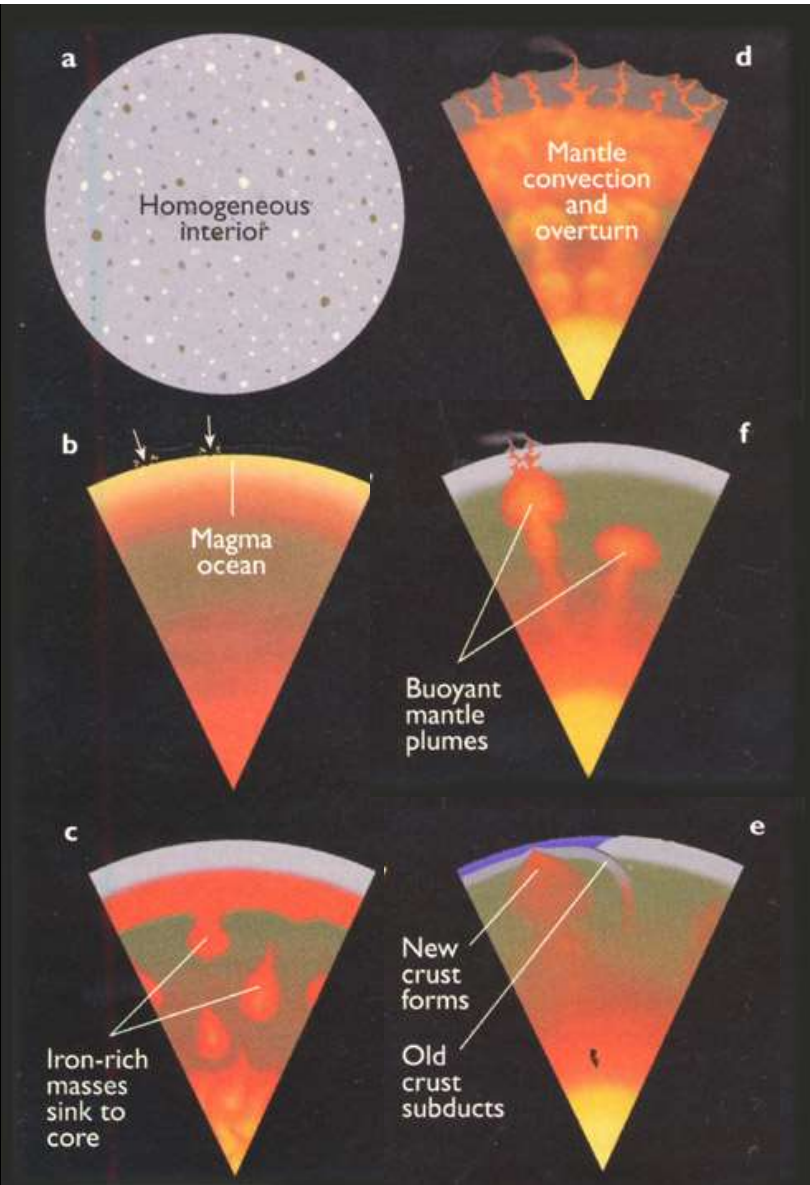
	Mars	Earth	Venus
Size (km)	6,800	12,800	12,100
Density (g/cm ³)	3.93	5.5 (4.5)	5.2 (4.5)
Year	687 d	365 d	225 d
Day	24 h 37 m	1 d (24h)	243 d Retro
Temperature	-120°	-28°	710°
(Fahrenheit)	-10°	116°	890°
Distance (AU)	1.5	1	0.7
Atmospheric Pres (Bars)	0.1	1	90
Gravity	.38	1	.91

Earth's History

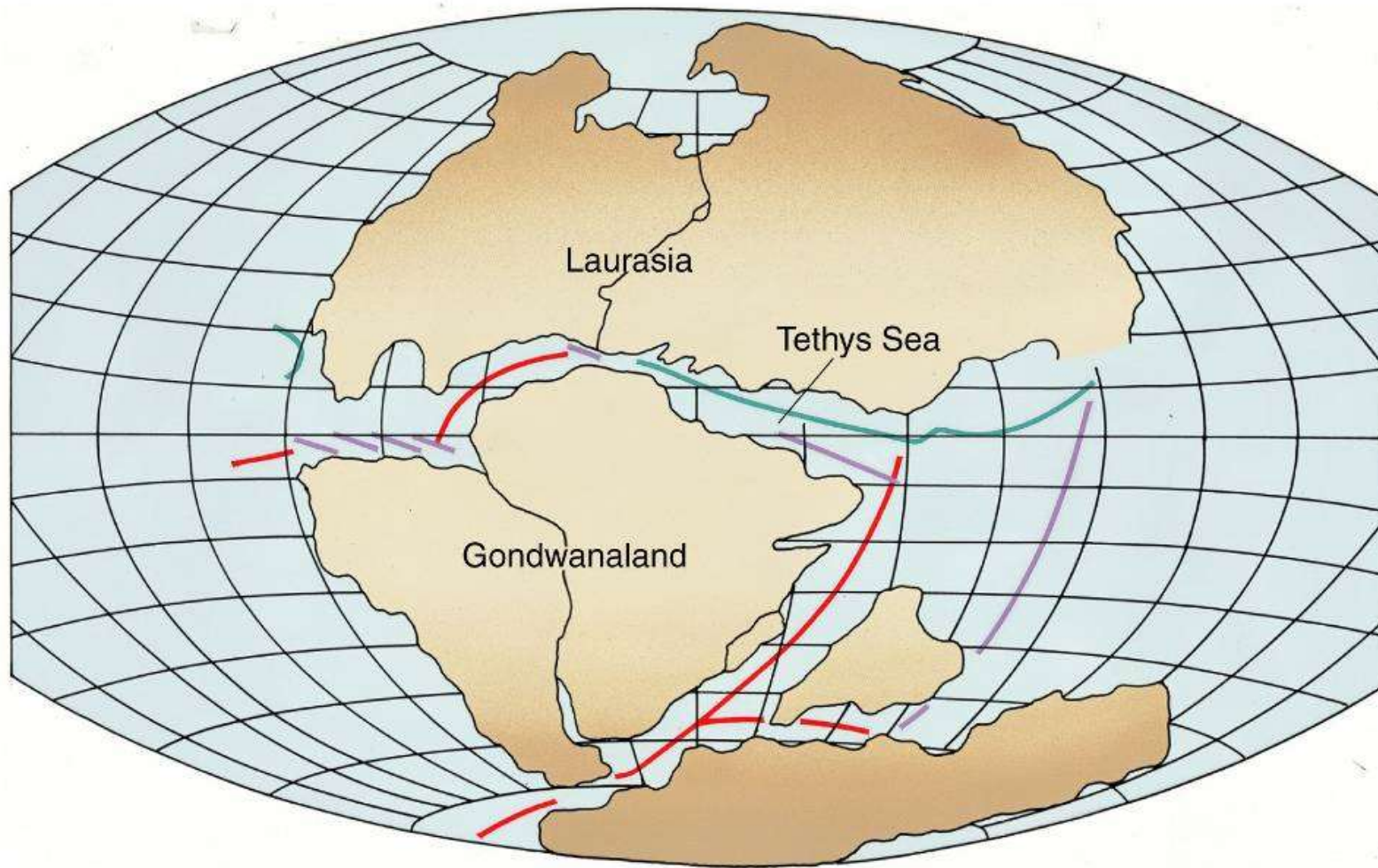


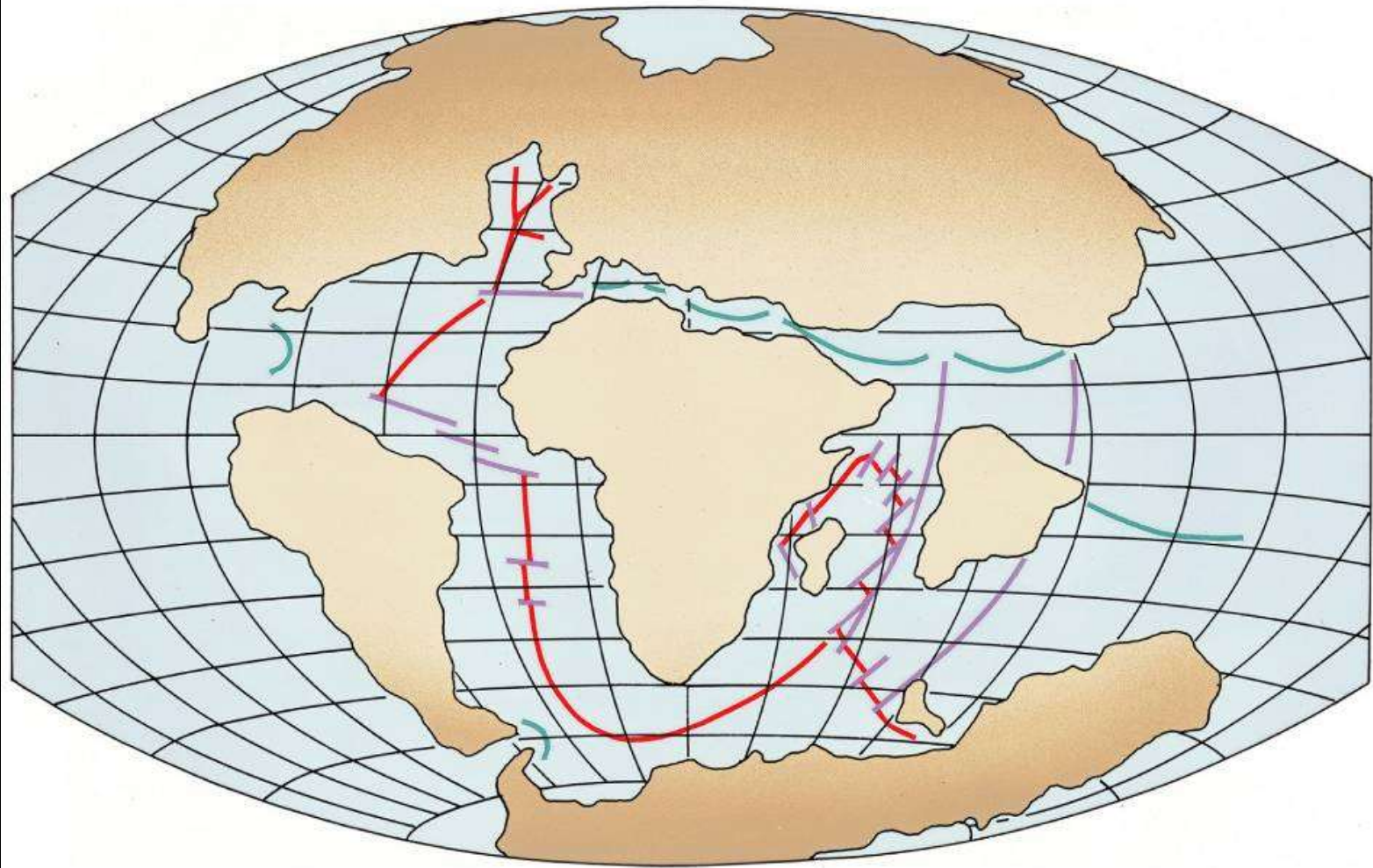
1. Earth forms
2. Early Earth bombarded by planetesimals.
3. Heavy elements, like Iron, sink to the core.
4. Rocky crust forms, first continents appear.
5. Today: Heat from the inside of the Earth fuels the movement of the continents, called plate tectonics.

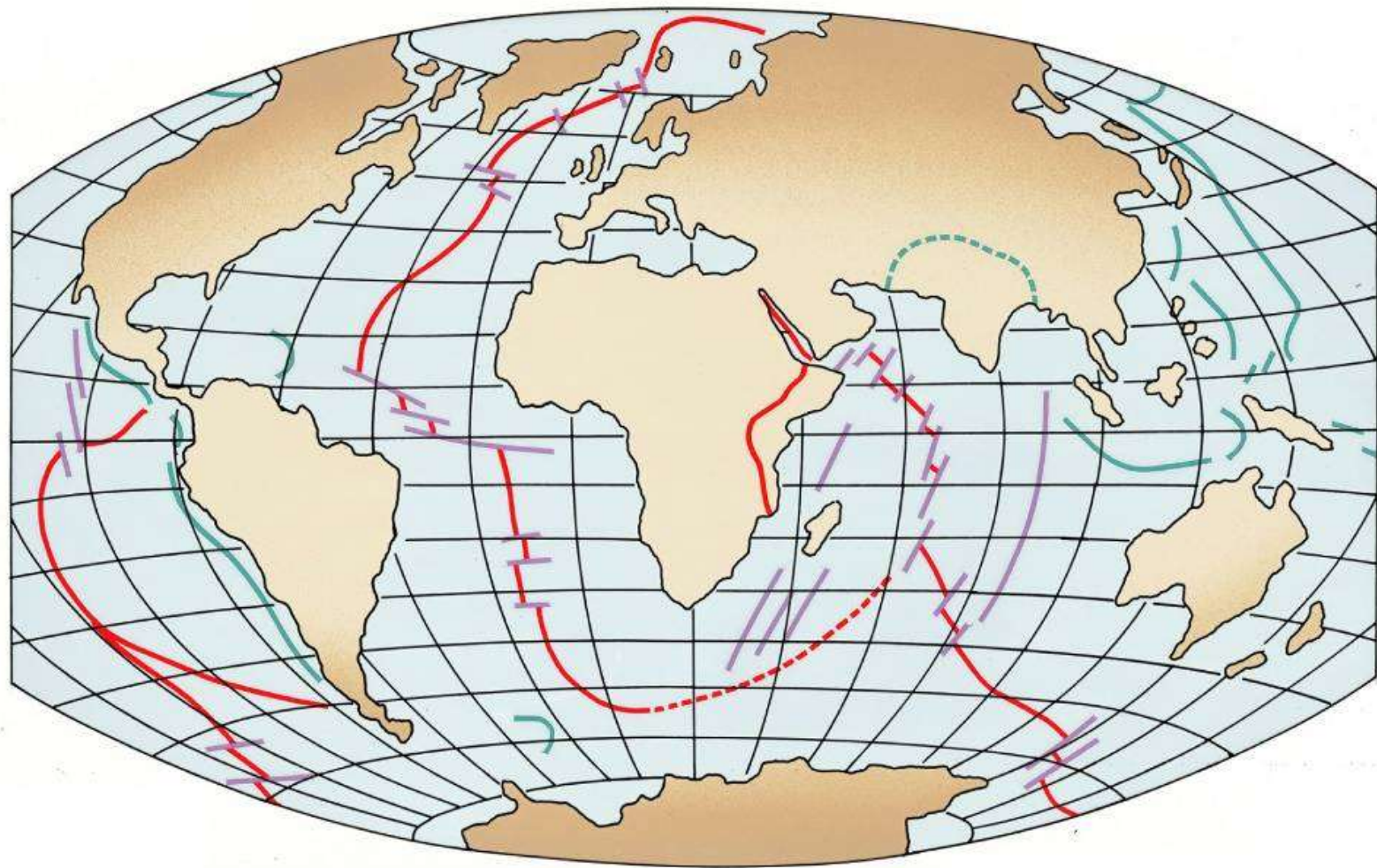
Internal Evolution of Earth



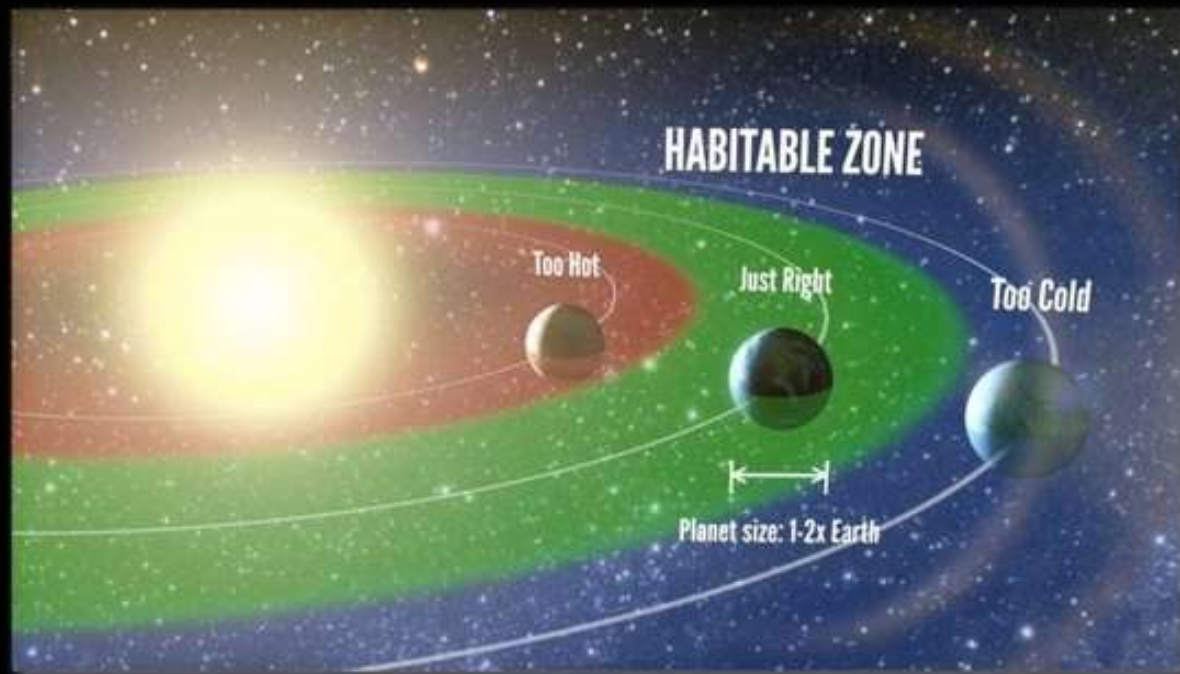
Plates





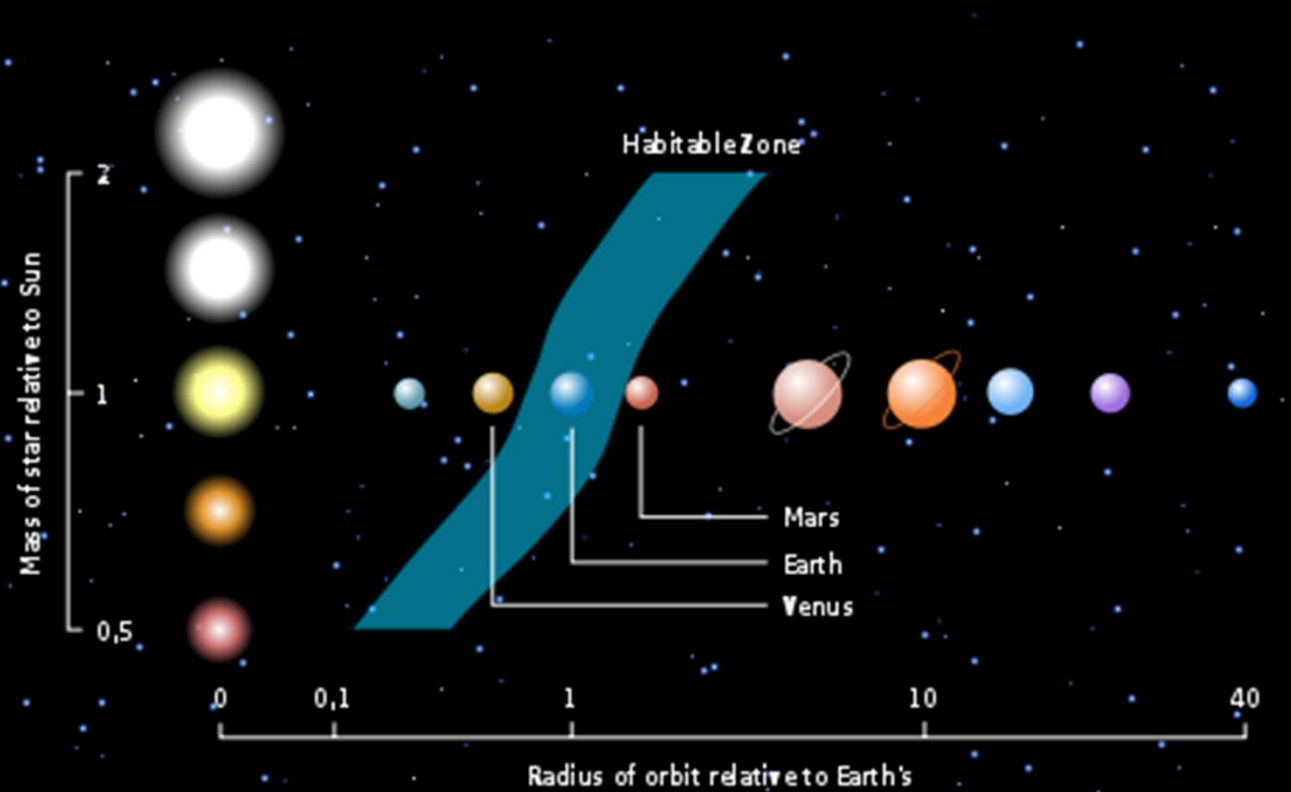


Goldilocks Zone



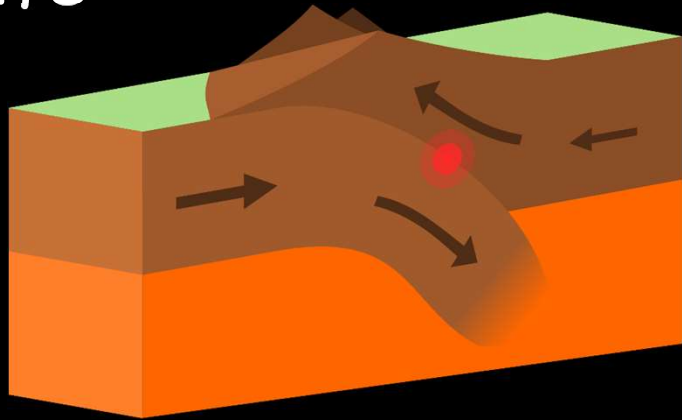
The habitable zone corresponds to the range of orbital distances where liquid water can exist on a planet's surface.

Other star systems

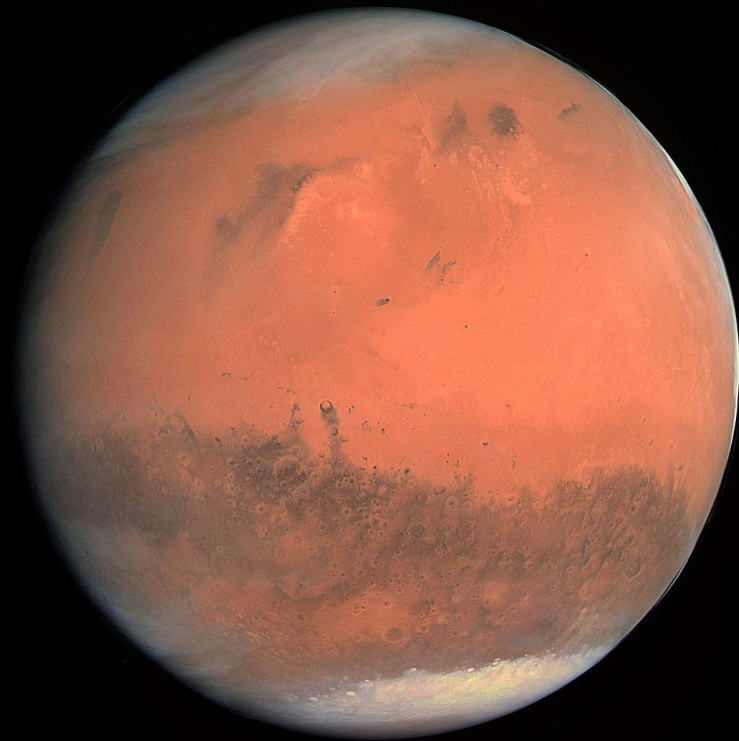


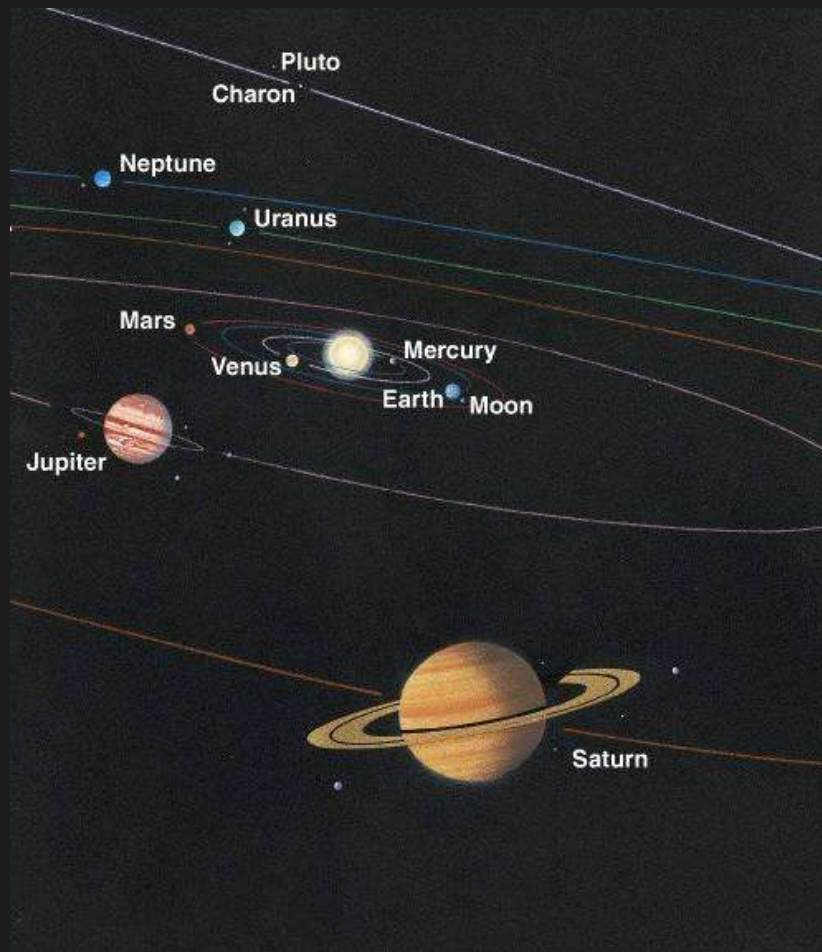
Unique to Earth:

- Liquid water!
- Moving plates
- Breathable oxygen atmosphere
- Life



MARS





Mars

- Sometimes voted planet most like Earth
- Visited by a multitude of spacecraft
- Flybys, orbiters, landers, and rovers
- Sample return yet to come— but we do have meteorites.



- Roman God Mars
- (Greek Ares)
- God of War
- Son of Jupiter

Mars

- Why study Mars?

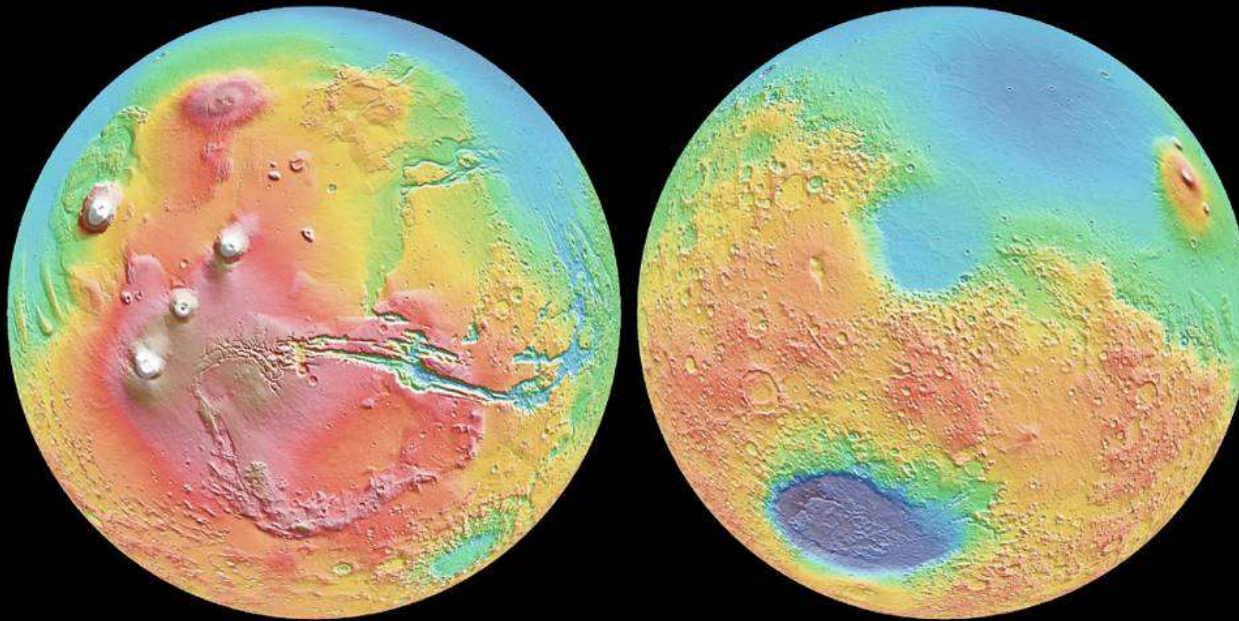




	Mars	Earth	Venus
Diameter (km)	6,800	12,800	12,100
Density (g/cm ³)	3.93	5.5 (4.5)	5.2 (4.5)
Year	687 d	365 d	225 d
Day	24 h 37 m	1 d	-243 d, Retro
Temperature	-120°	-28°	710°
(Fahrenheit)	-10°	116°	890°
Distance (AU)	1.5	1	0.7
Atmospheric Pres (Bars)	0.1	1	90
Gravity	.38	1	.91
Moons	2	1	0

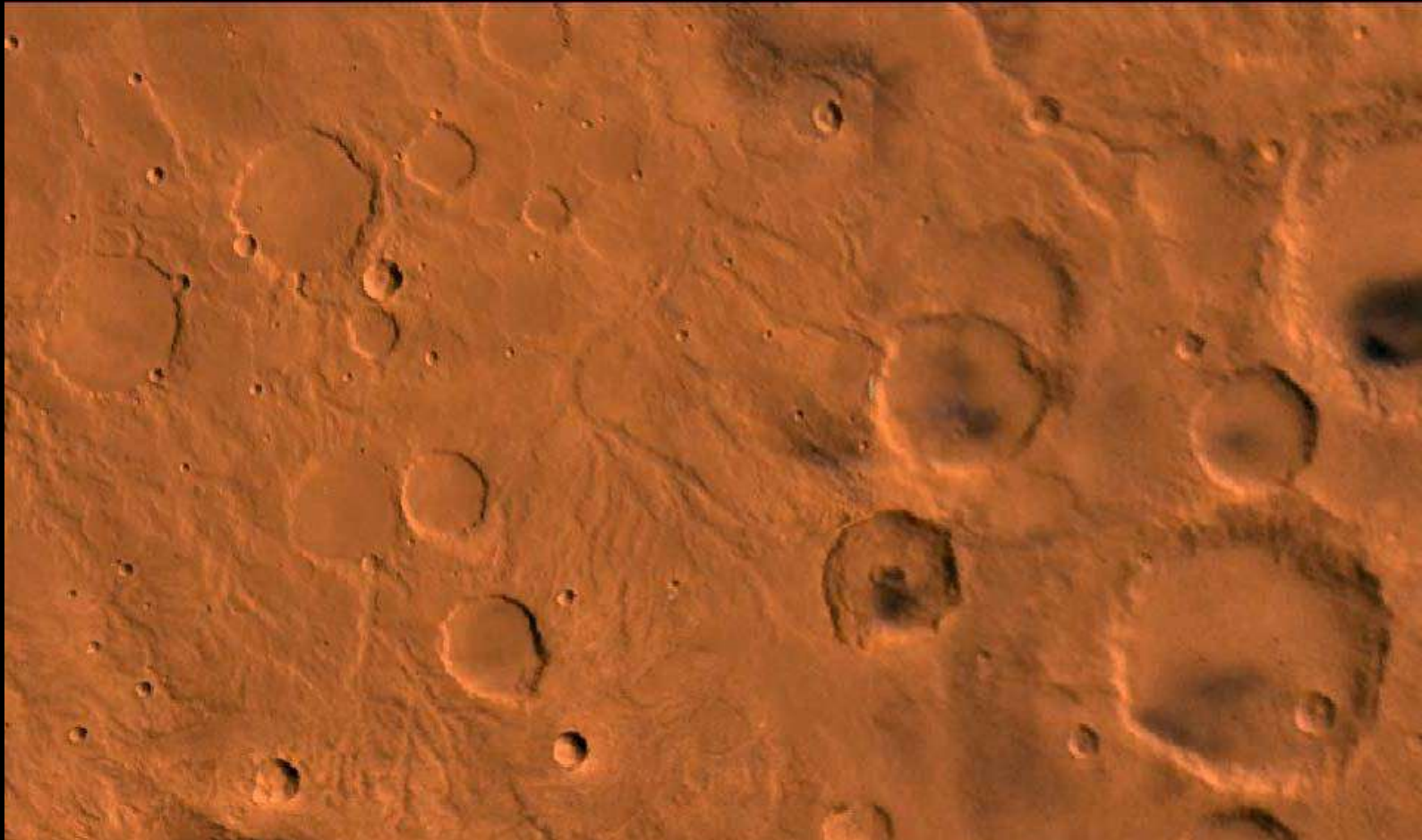
Major Provinces of Mars: Topographic Map

From MOLA on MGS

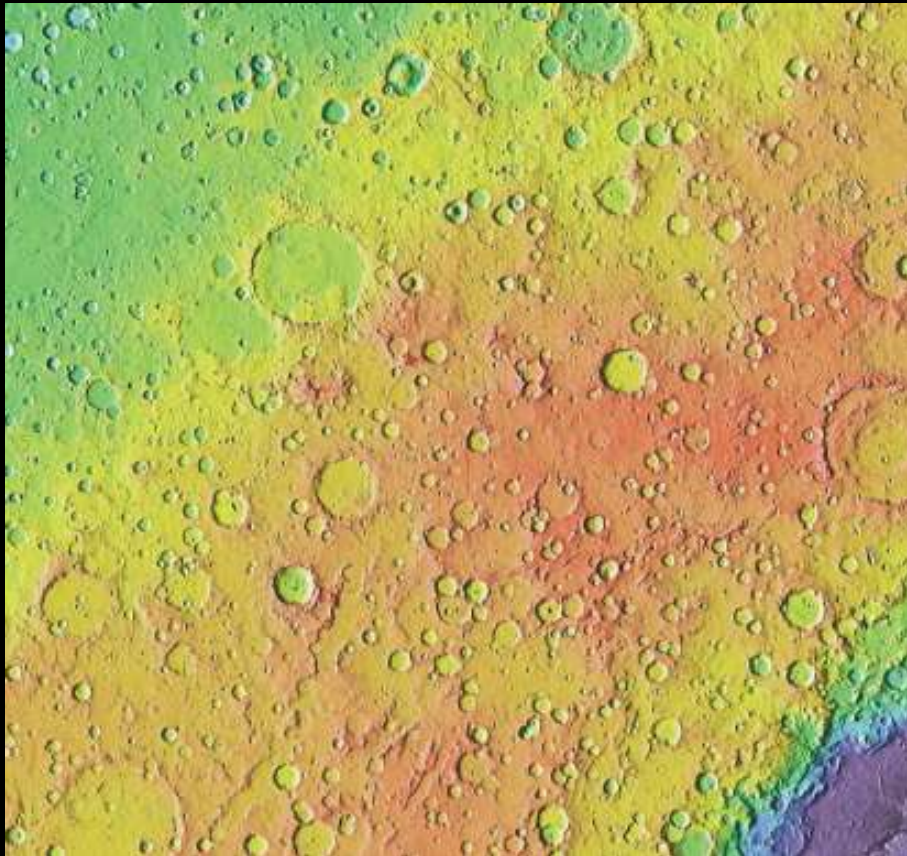


- I want you to know only two provinces:
1. Low plains in the North
 2. Cratered highlands in the South

Southern Cratered Highlands

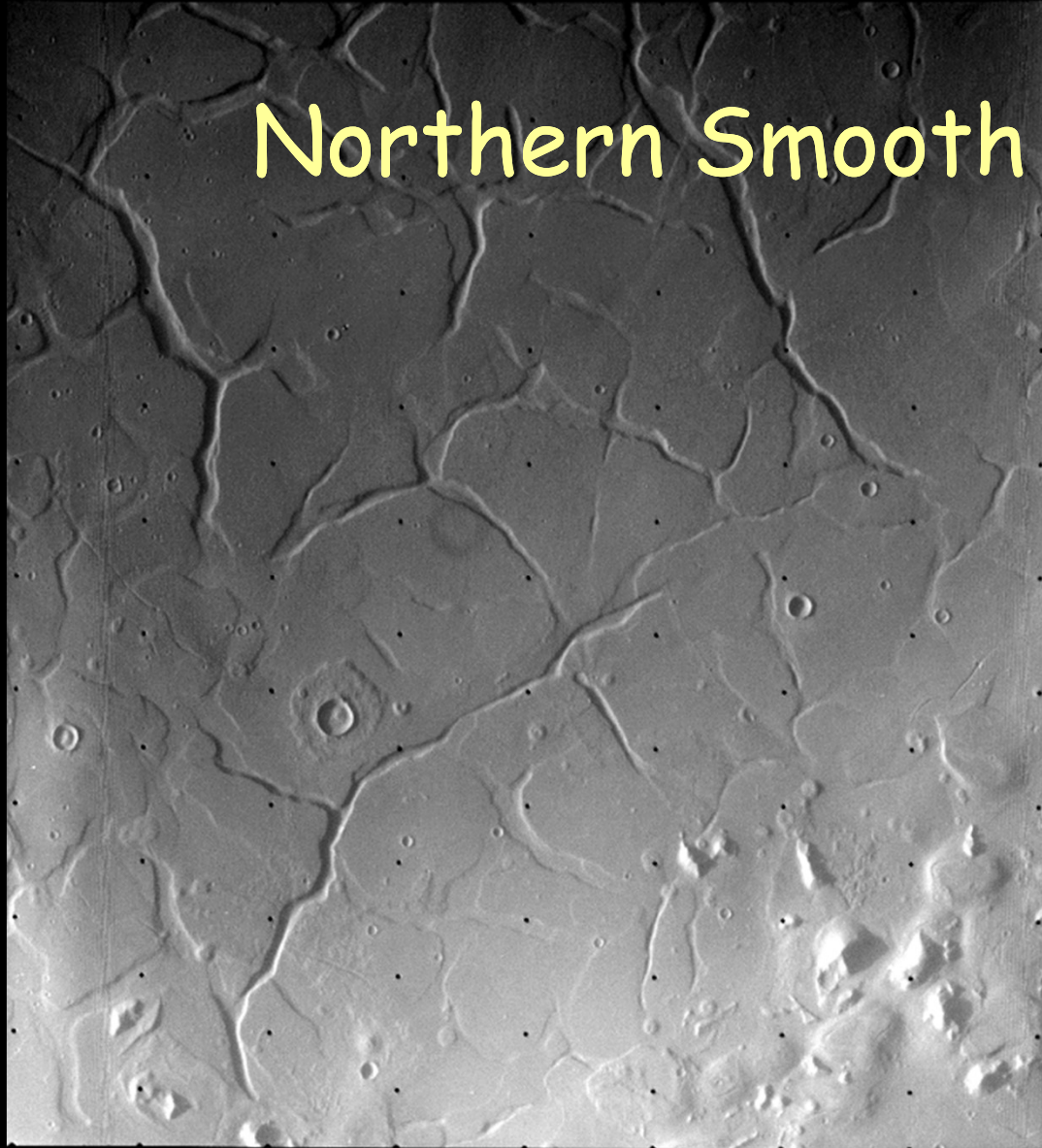


Southern Cratered Highlands



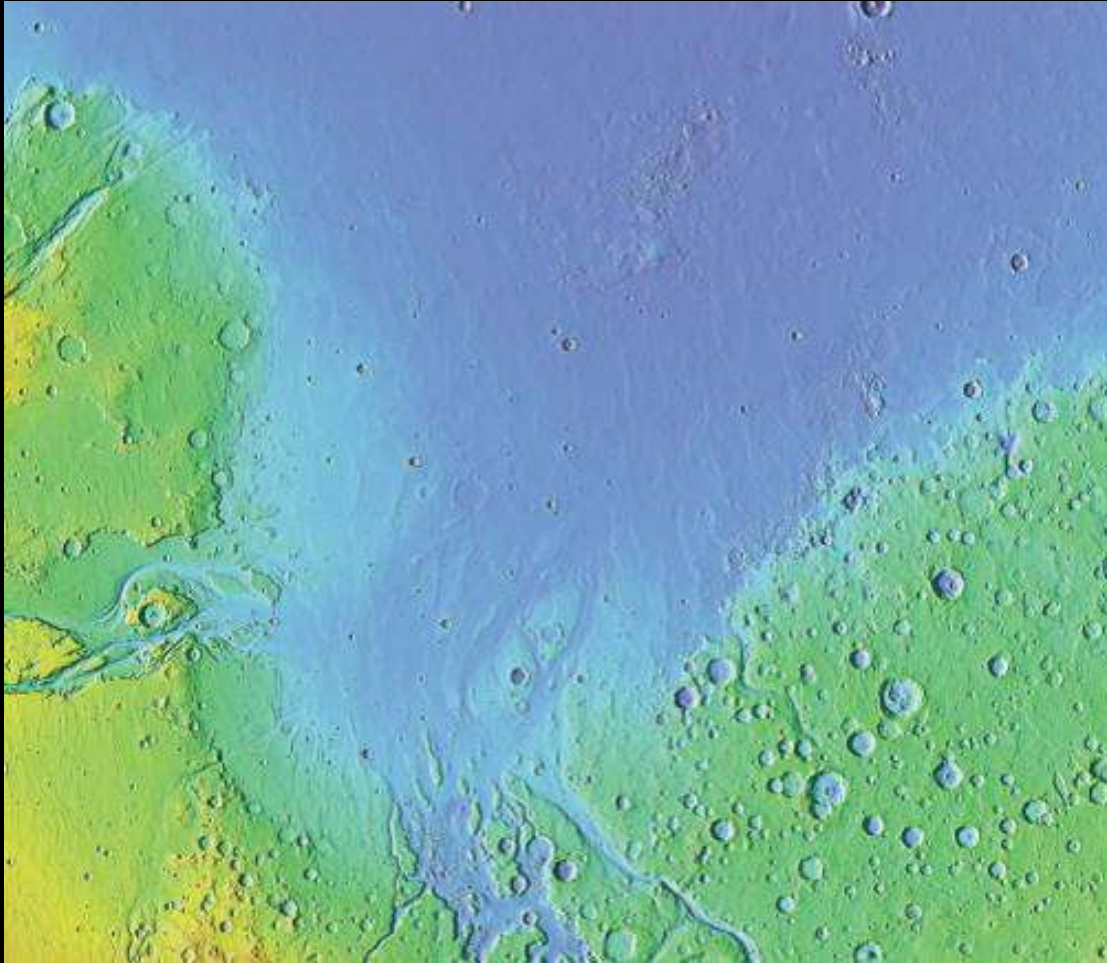
- High
- Many, many craters
- Old surface

Northern Smooth Plains



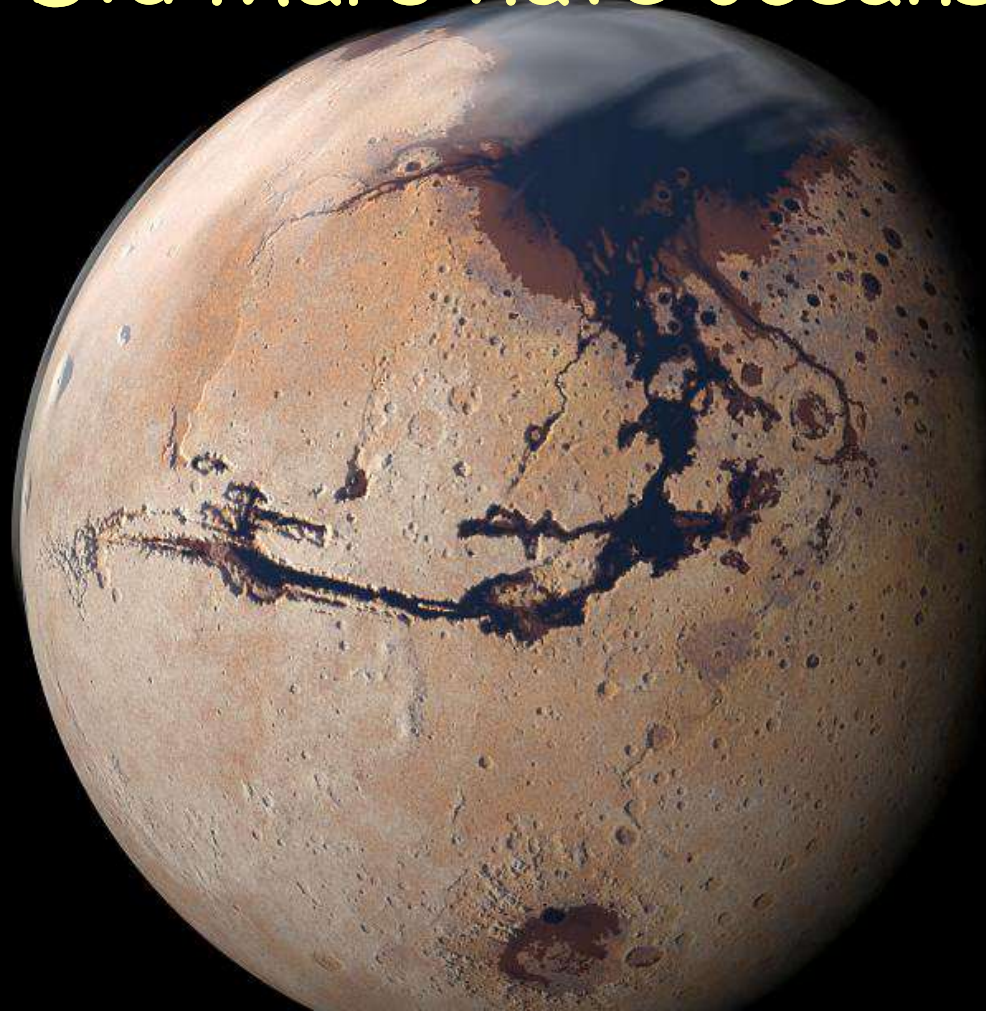
- Low smooth plains
- Partly volcanic

Northern Smooth Plains



- Low smooth plains
- Partly volcanic
- Younger surface

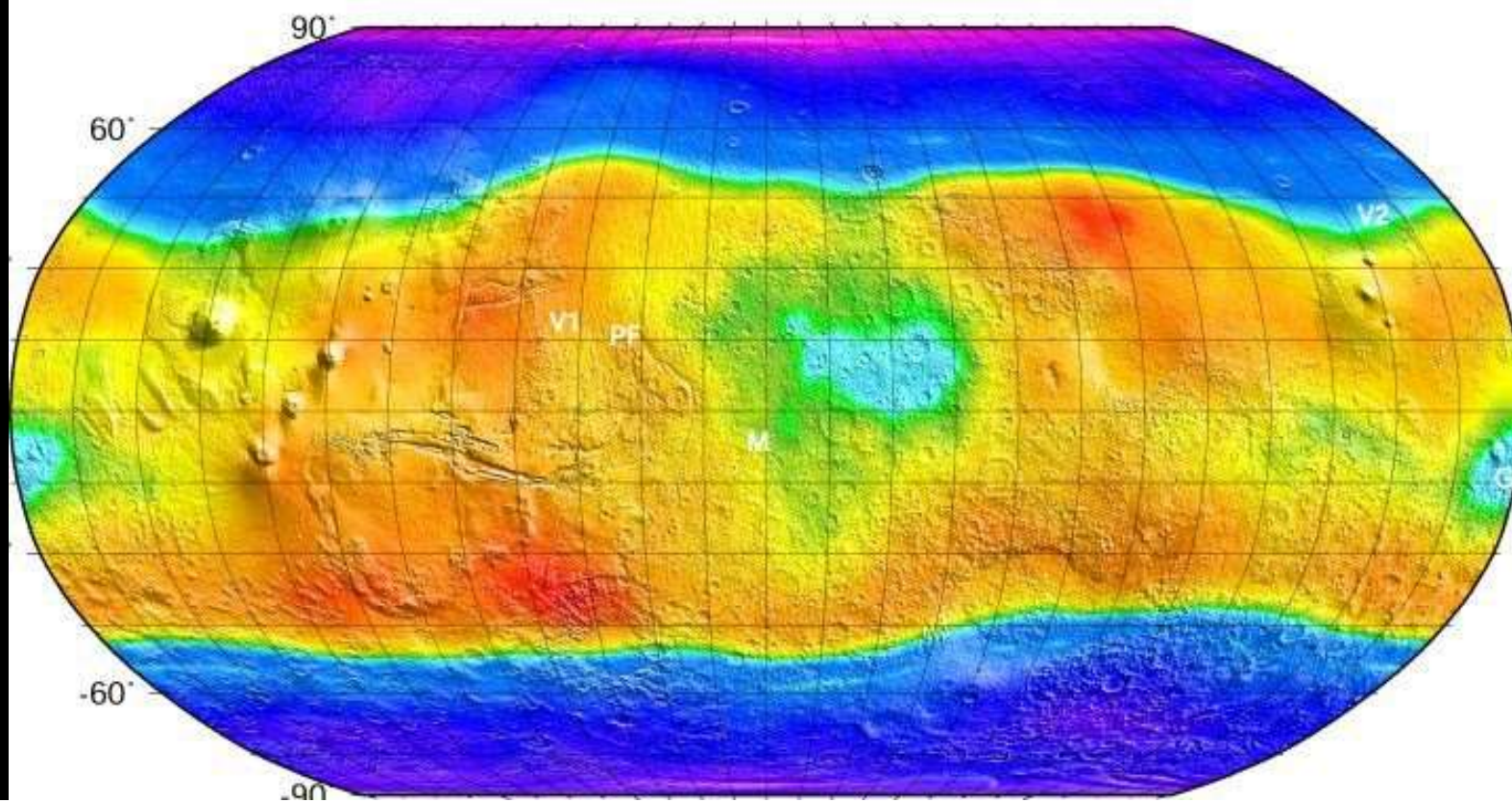
Did Mars have oceans?



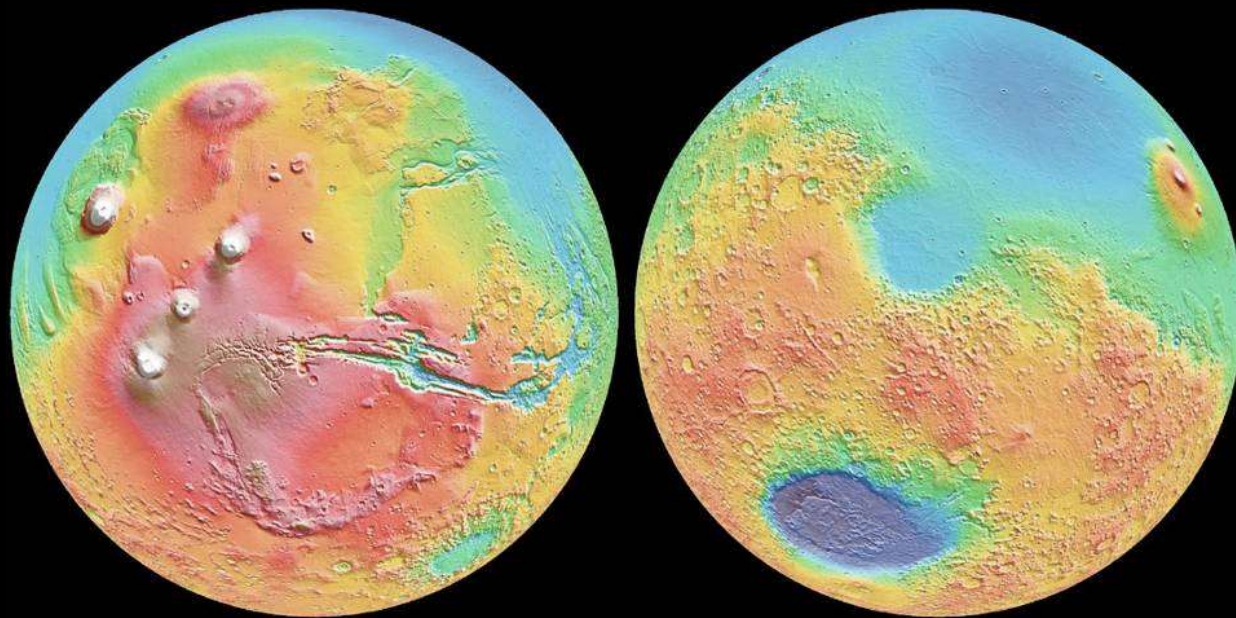
Water Map

2001 Mars Odyssey Gamma Ray Spectrometer

H2O Low  H2O High



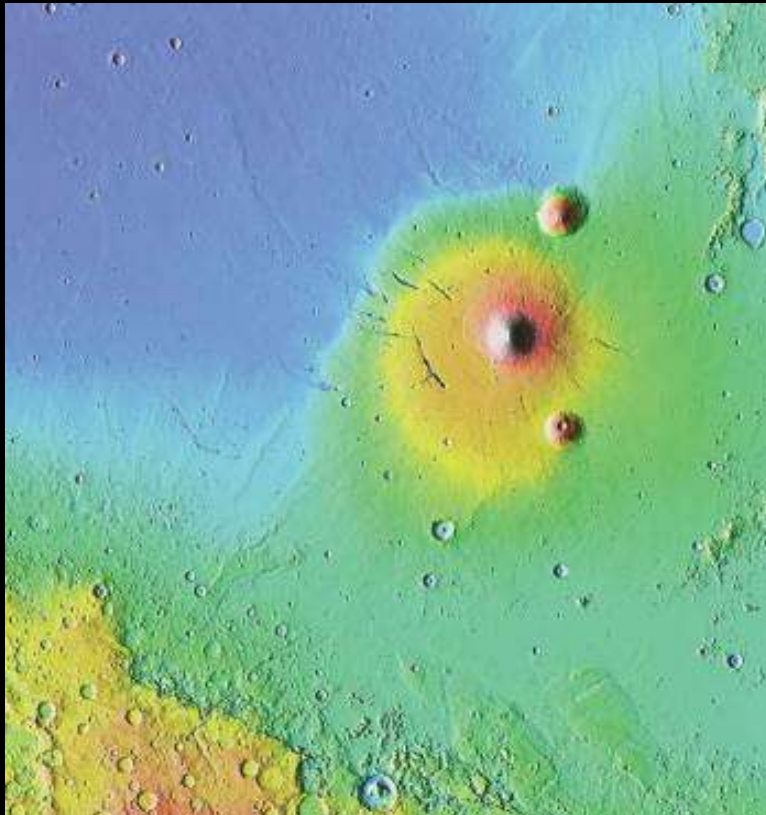
Oceans?



Features of Mars

- Olympus Mons
- Valles Marineris
- Polar Ice Caps

Crustal Domes - Olympus Mons



- Not seen on Mercury or Moon
- Continent-sized features
- Shield volcanoes

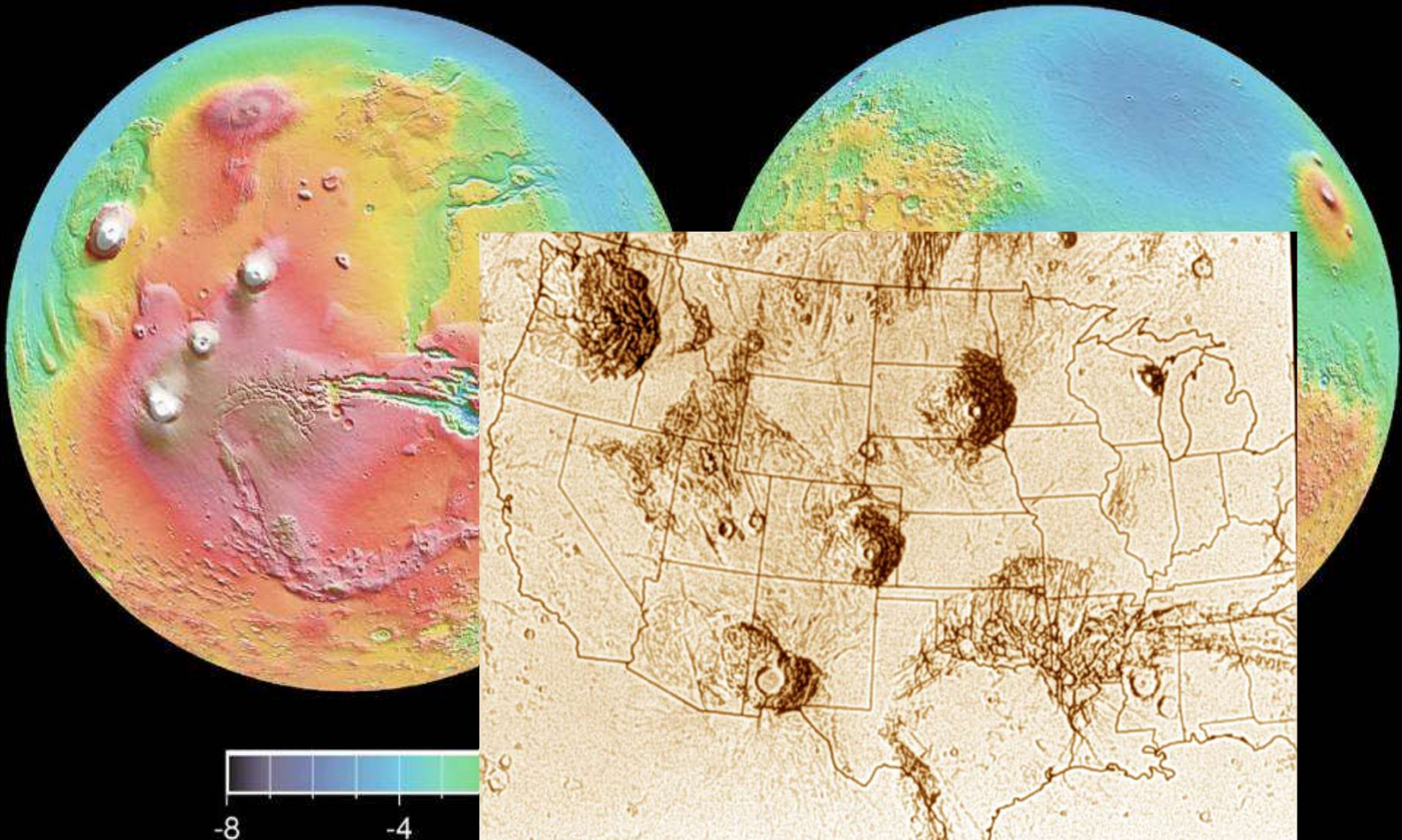
Elysium Planitia ~2500 km

Olympus Mons

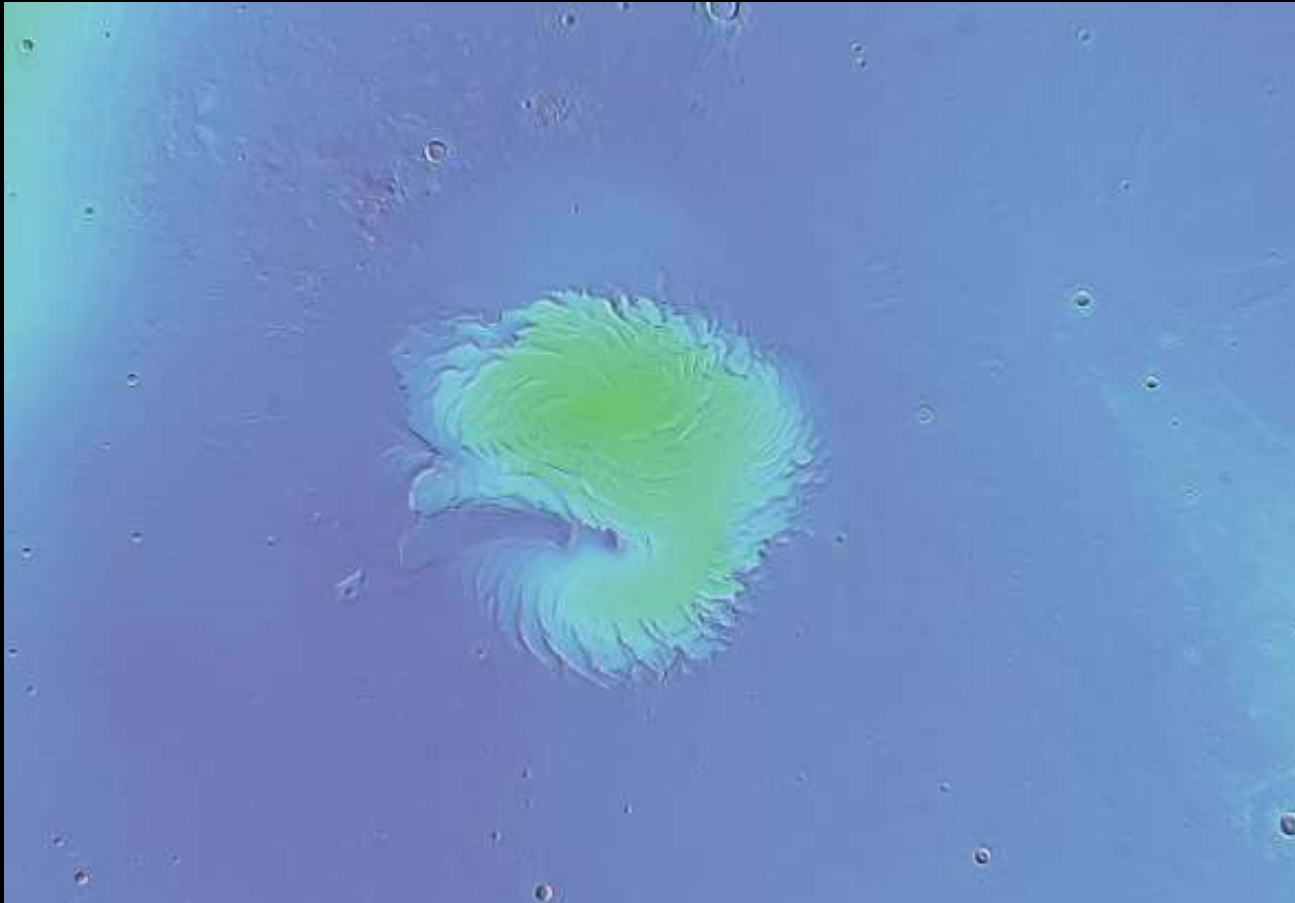


Crustal Domes

Tharsis 3000-4000 km



Polar Ice Caps



- Seen with telescopes
- Retreat with seasons
- Made of what?
- Water ice
- Carbon dioxide ice
- Ring of sand dunes

Polar Ice Caps



- Seen with telescopes
- Retreat with seasons
- Water ice
- Carbon dioxide ice
- Ring of sand dunes

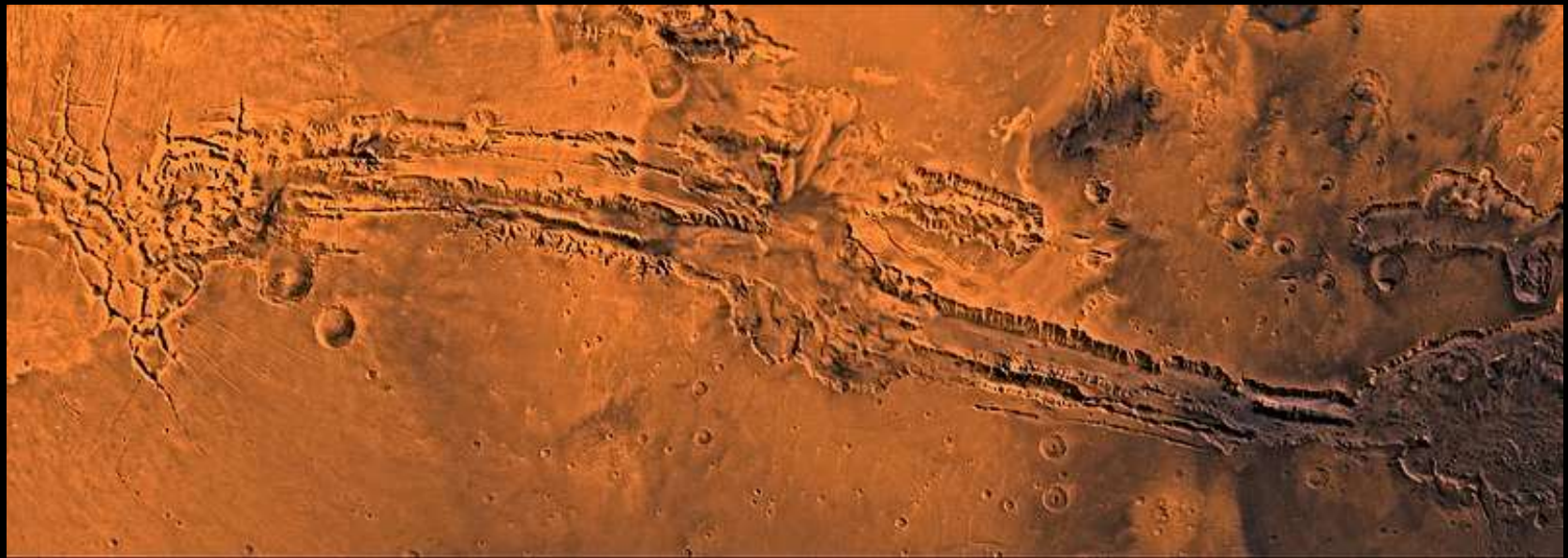


Mars
North Polar Cap

HST • WFPC2

PRC97-15b • ST ScI OPO • May 20, 1997
P. James (Univ. Toledo), T. Clancy (Space Science Inst.), S. Lee (Univ. Colorado) and NASA

Valles Marineris





Grand Canyon
18 miles wide, 1 mile deep

Valles Marineris 150 miles wide, 4 miles deep

VERTICAL SCALE EXAGGERATED 4 TIMES



Mars Rovers

Spirit and Opportunity

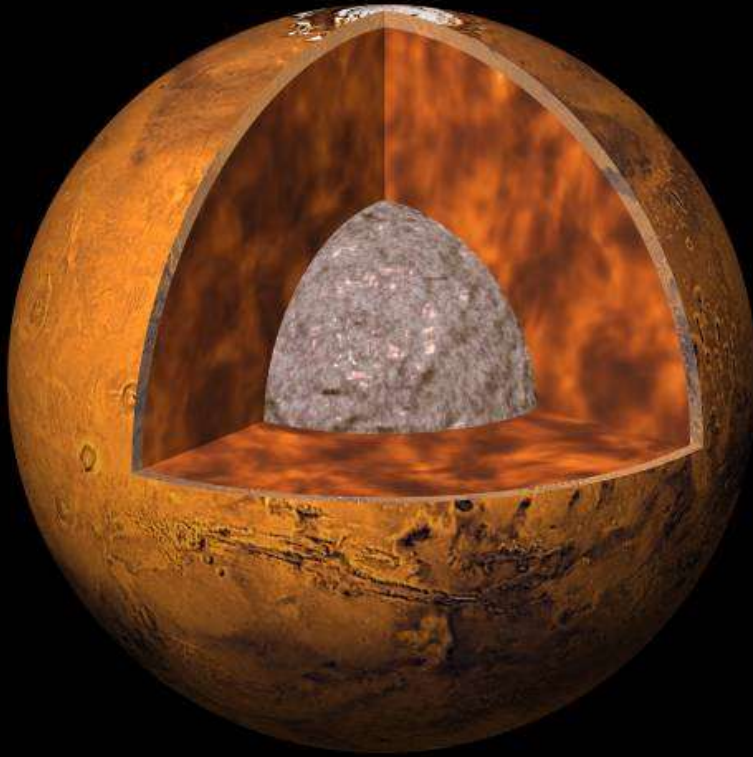
2003 to present

Opportunity still
moving

Curiosity - 2012 to
present

<https://www.youtube.com/watch?v=h2I8AoB1xgU>

Internal Structure of Mars



- Diameter 6800 km
- Density 3.9 g/cm³
- Atmosphere
 - 0.6% Earth
 - CO₂
- Crust
- Iron/rocky Mantle - Why is Mars red?
- Iron Core

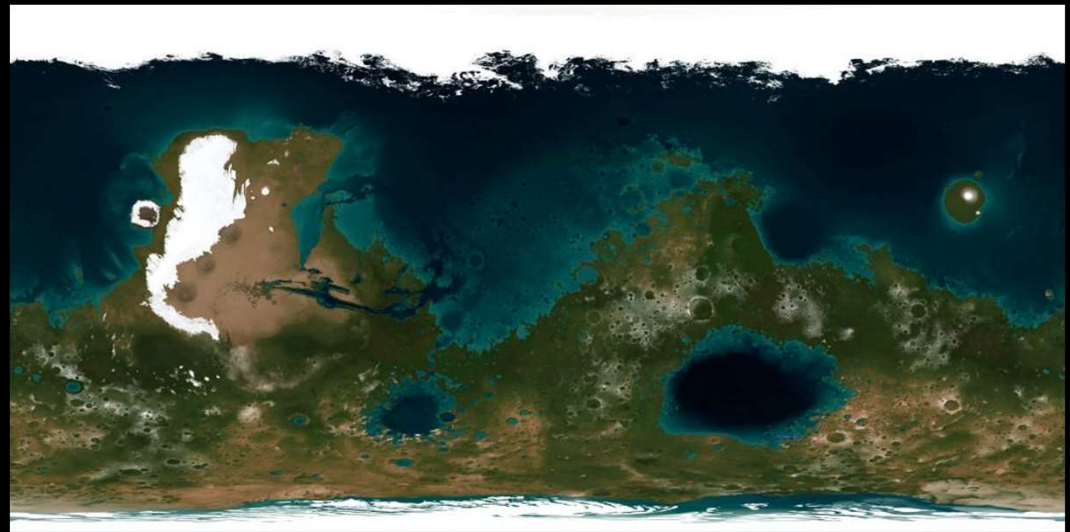
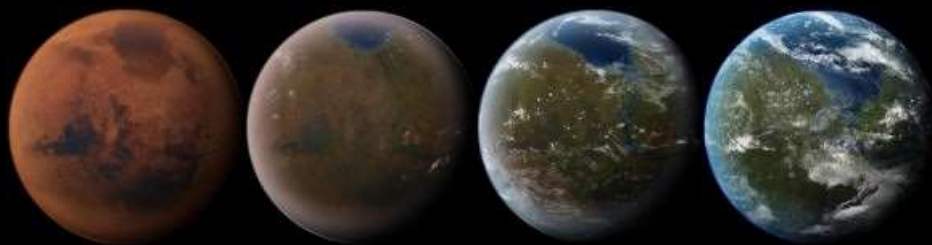
Mars' thin atmosphere



- <https://www.youtube.com/watch?v=s0V-kqIe4pw>



Terraforming



Was Mars ever livable? Can we make it livable again?