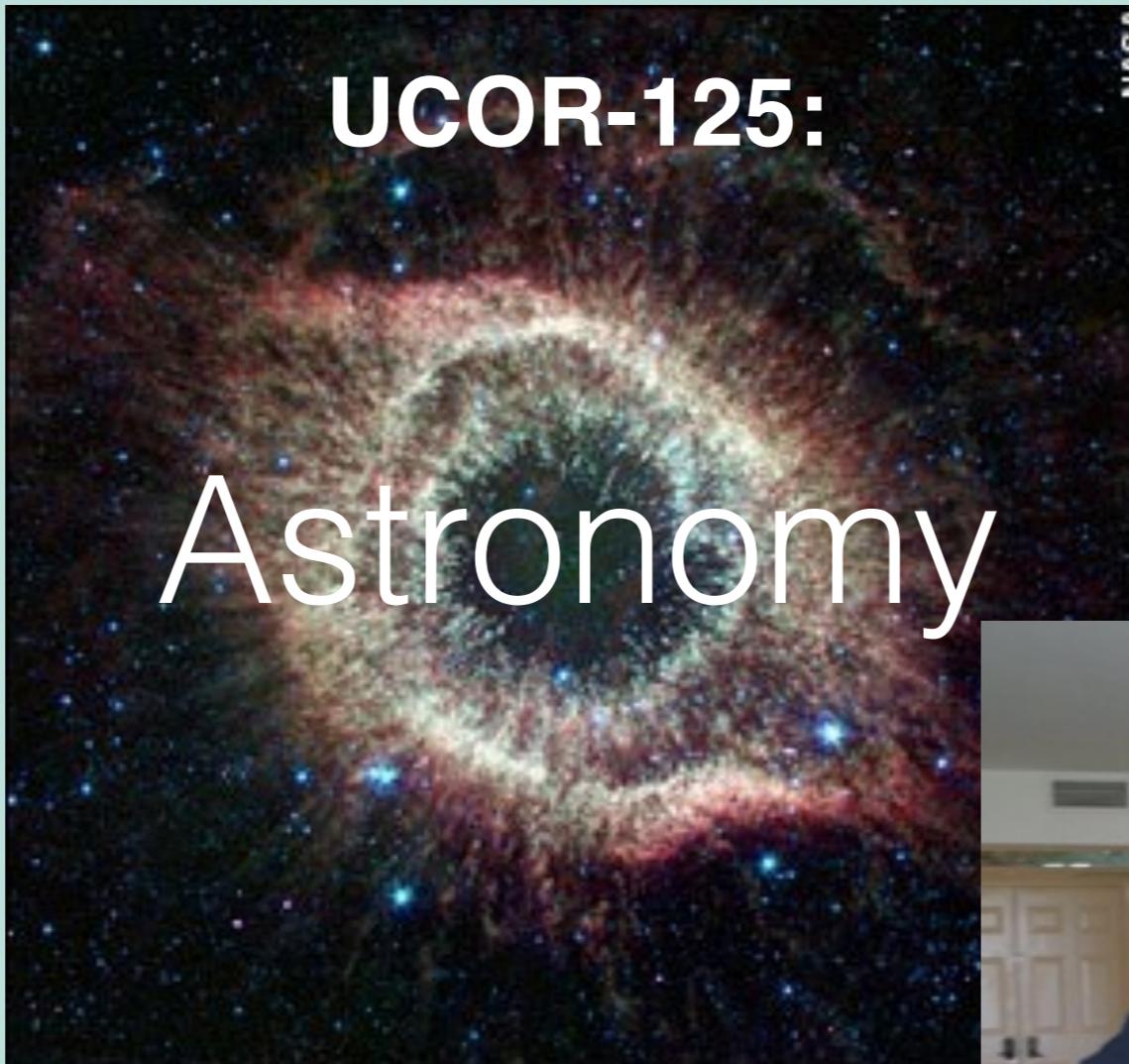




Lecture 9: Mars



UCOR-125:

Astronomy

with your host:



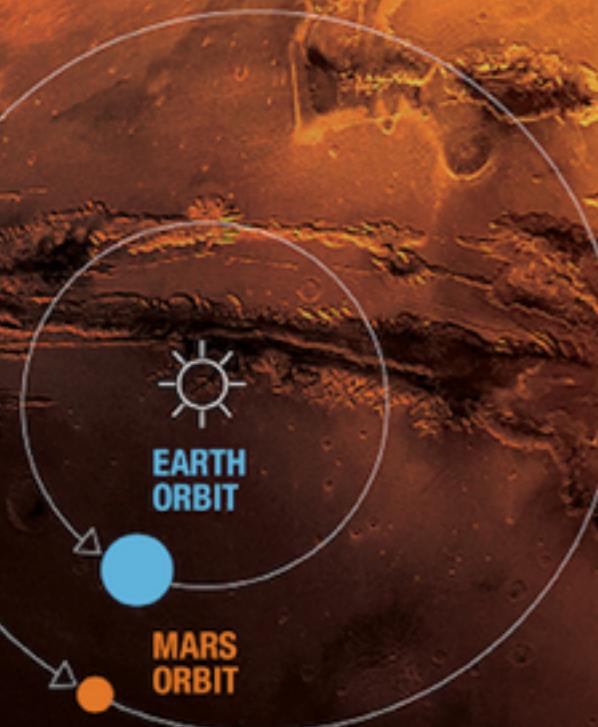
Coop

Mars: Ch 10



www.csanet.ca

MARS



Because Mars's orbit is different from Earth's, there is one launch window every 26 months

26
MONTHS

55.7
401^{TO}
MILLION
KILOMETRES

Distance from Mars to Earth depending on its orbit



Using current technology, it would take over two years for a team of astronauts to travel to Mars and back.

MARS
HALF
THE SIZE OF
EARTH



MARS
1/10TH
THE MASS OF
EARTH

687
ONE YEAR
ON MARS

Number of Earth days it takes for Mars to make one revolution around the Sun

365
ONE YEAR
ON EARTH

Number of days it takes for Earth to make one revolution around the Sun



-55
DEGREES
CELSIUS

Is the average temperature. When the sun is shining in the summer, the temperature near the Martian equator can reach 20 degrees Celsius, but it drops to -100 degrees Celsius at night!



144
KM/H

Highest wind speed recorded on Mars



Water has been found on Mars in the form of vapour, ice and snow.



24 HOURS,
39 MINUTES,
35 SECONDS

Length of a Martian day, known as a "sol"



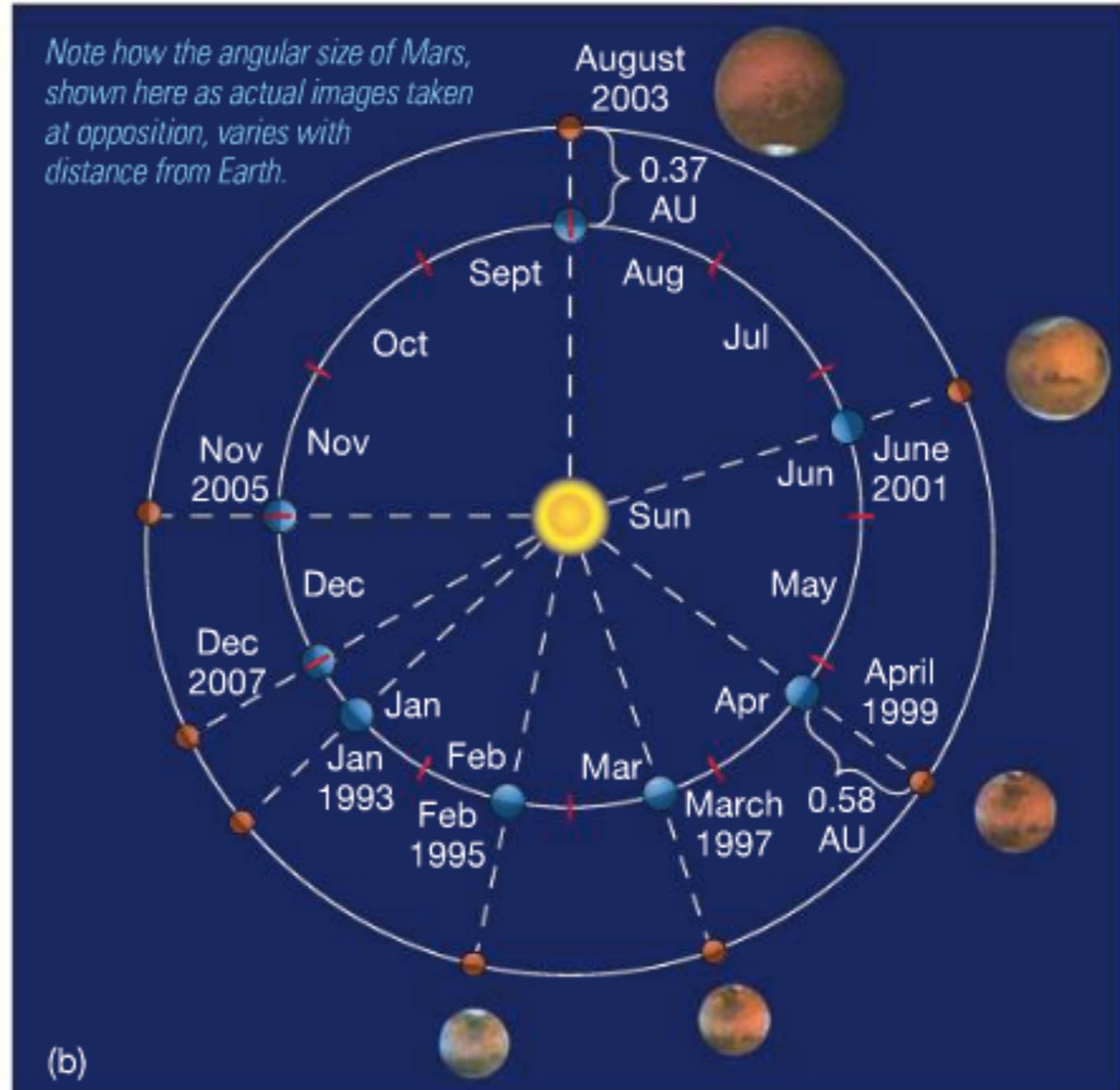
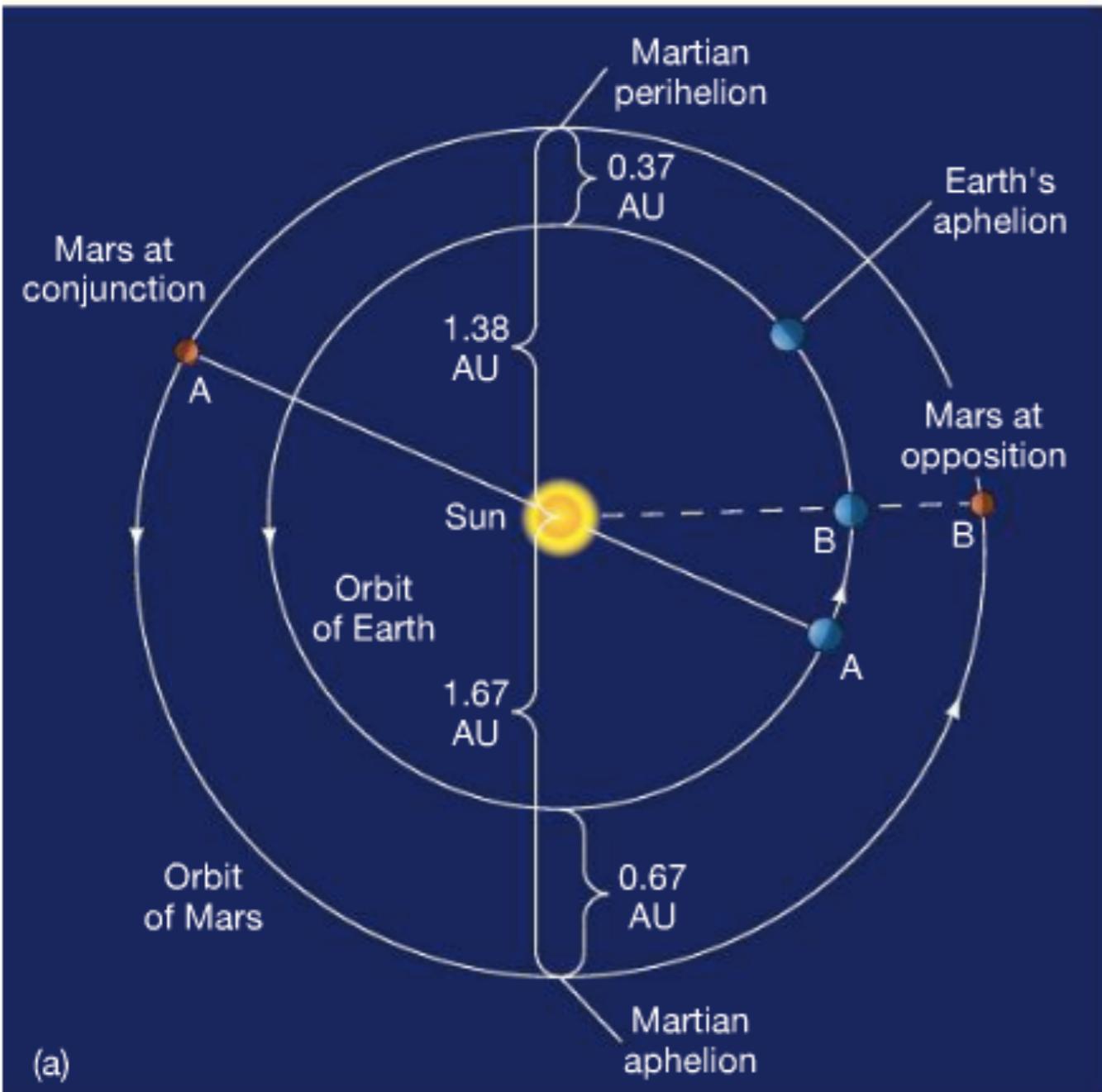
26
KILOMETRES

Height of Olympus Mons, the highest known mountain in the solar system (over three times the height of Mount Everest)

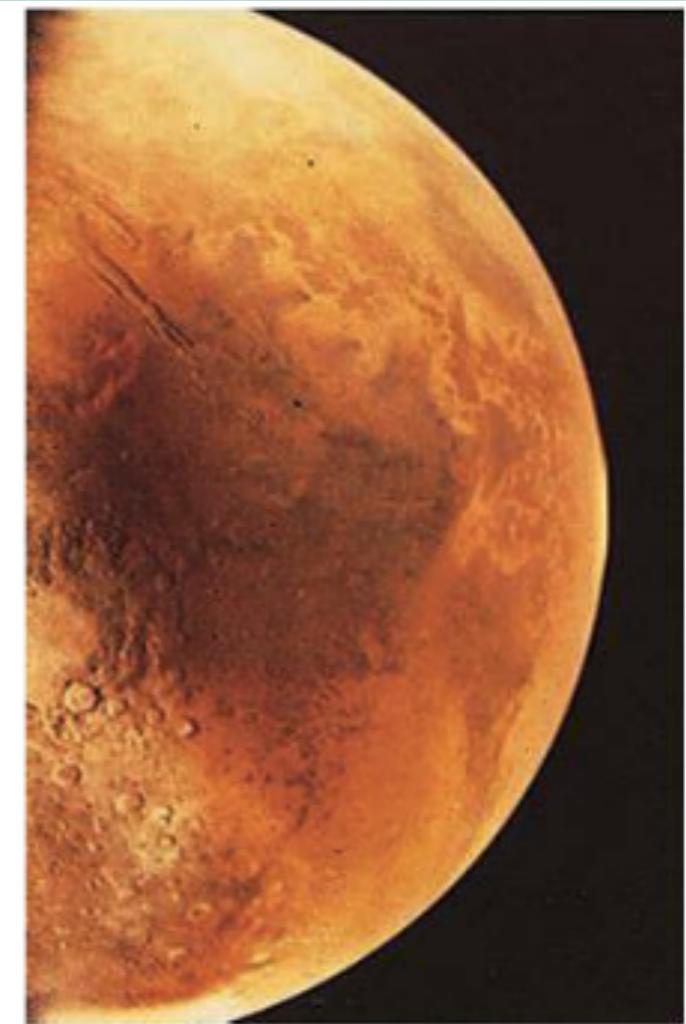
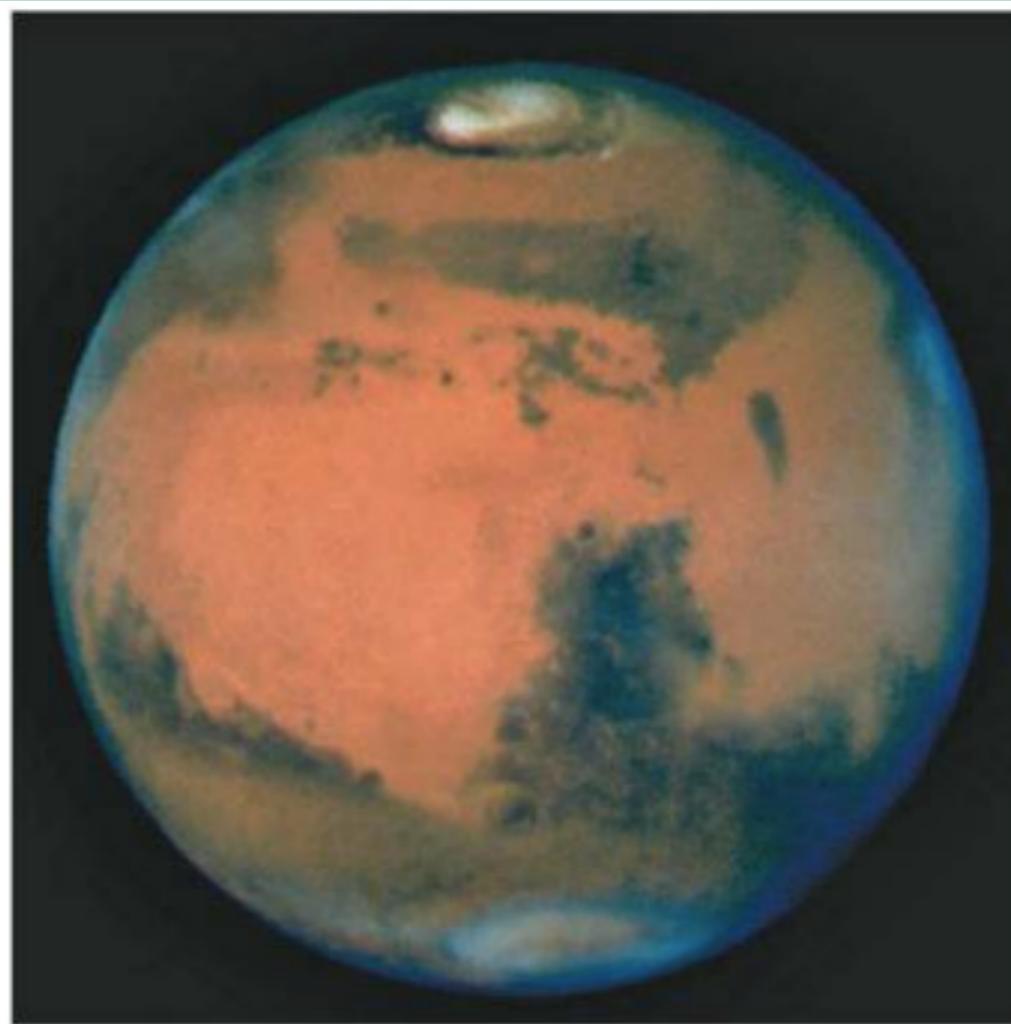
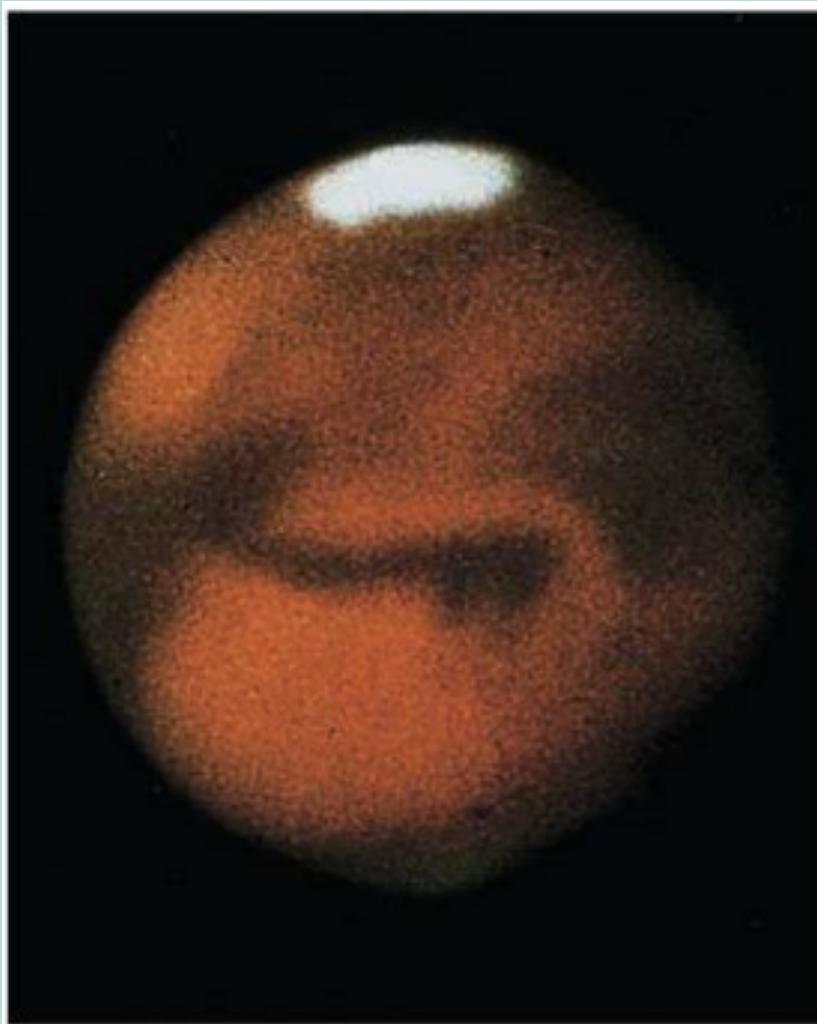
Mars: Ch 10

- * Eccentricity is .093, most besides mercury. 45% more sunlight at perihelion
- * Superior orbit so strays far from sun, sometimes in retrograde
- * Same tilt, so seasons, but slightly different due to eccentricity, southern summer happens at perihelion so is quite warm.
- * crazy winds kick up lots of dust (still 100X less erosion than Earth)
 - * Angular size 25"

Mars' Eccentricity

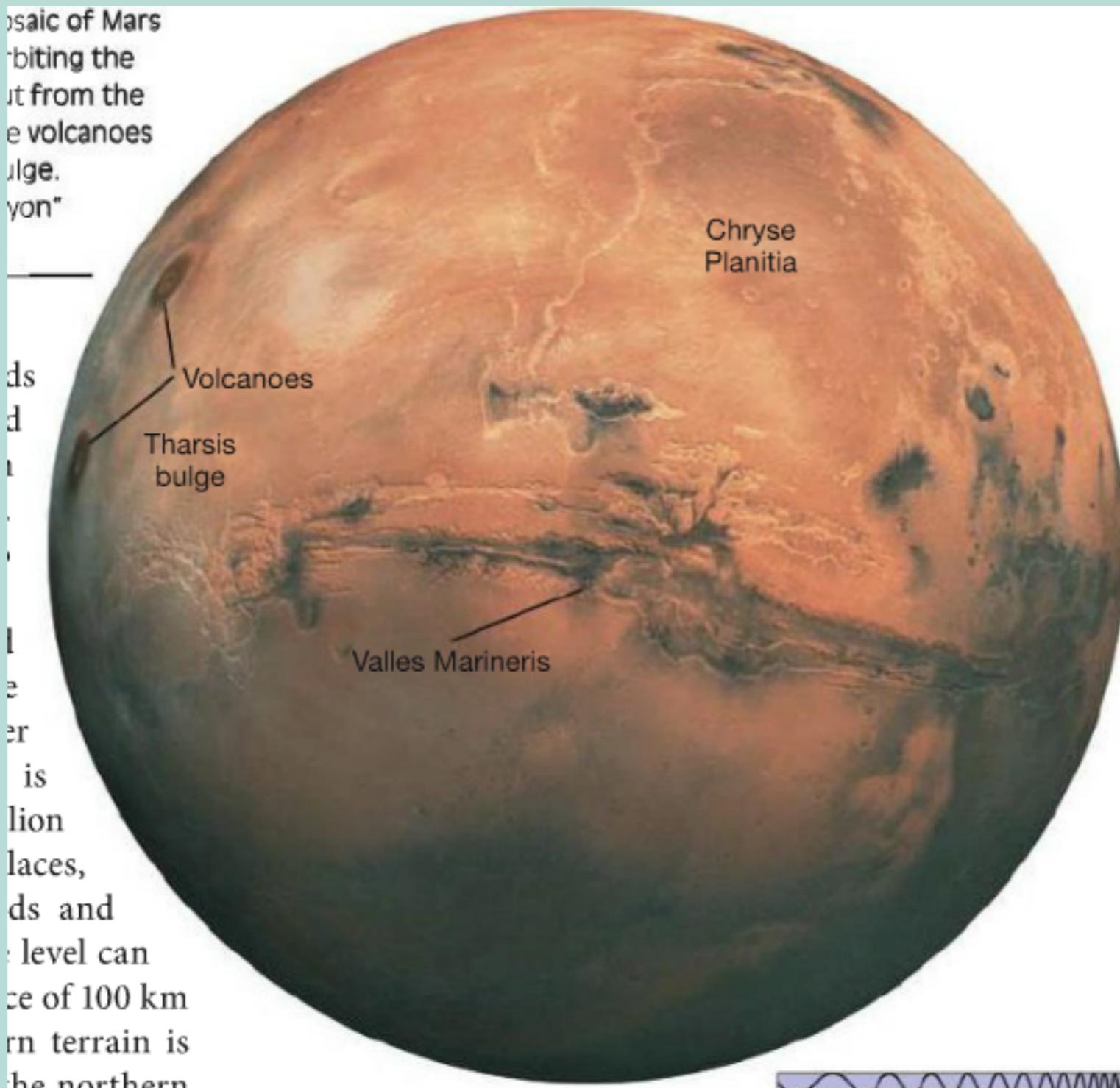


Three Views of Mars



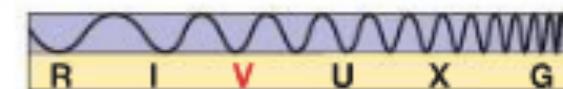
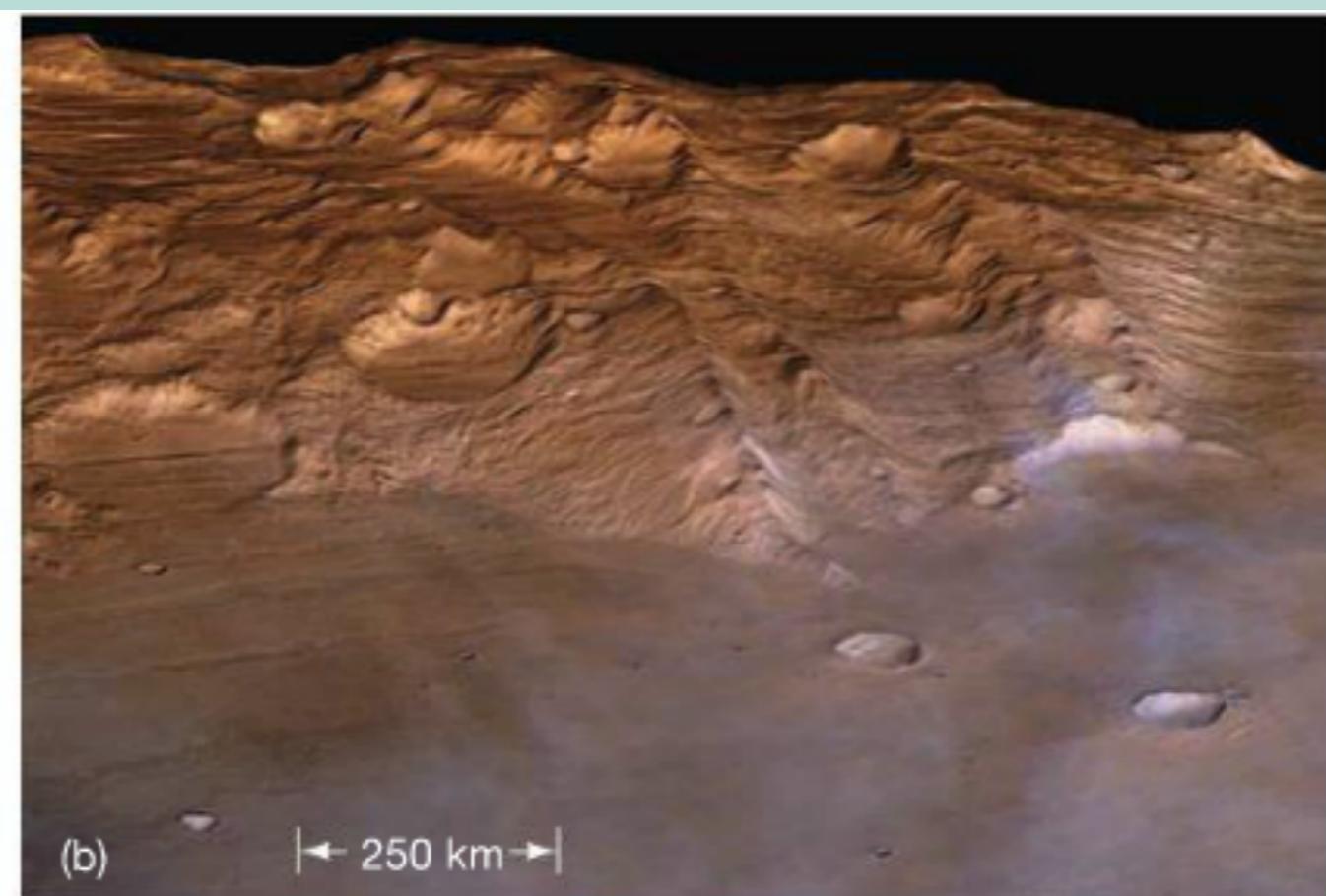
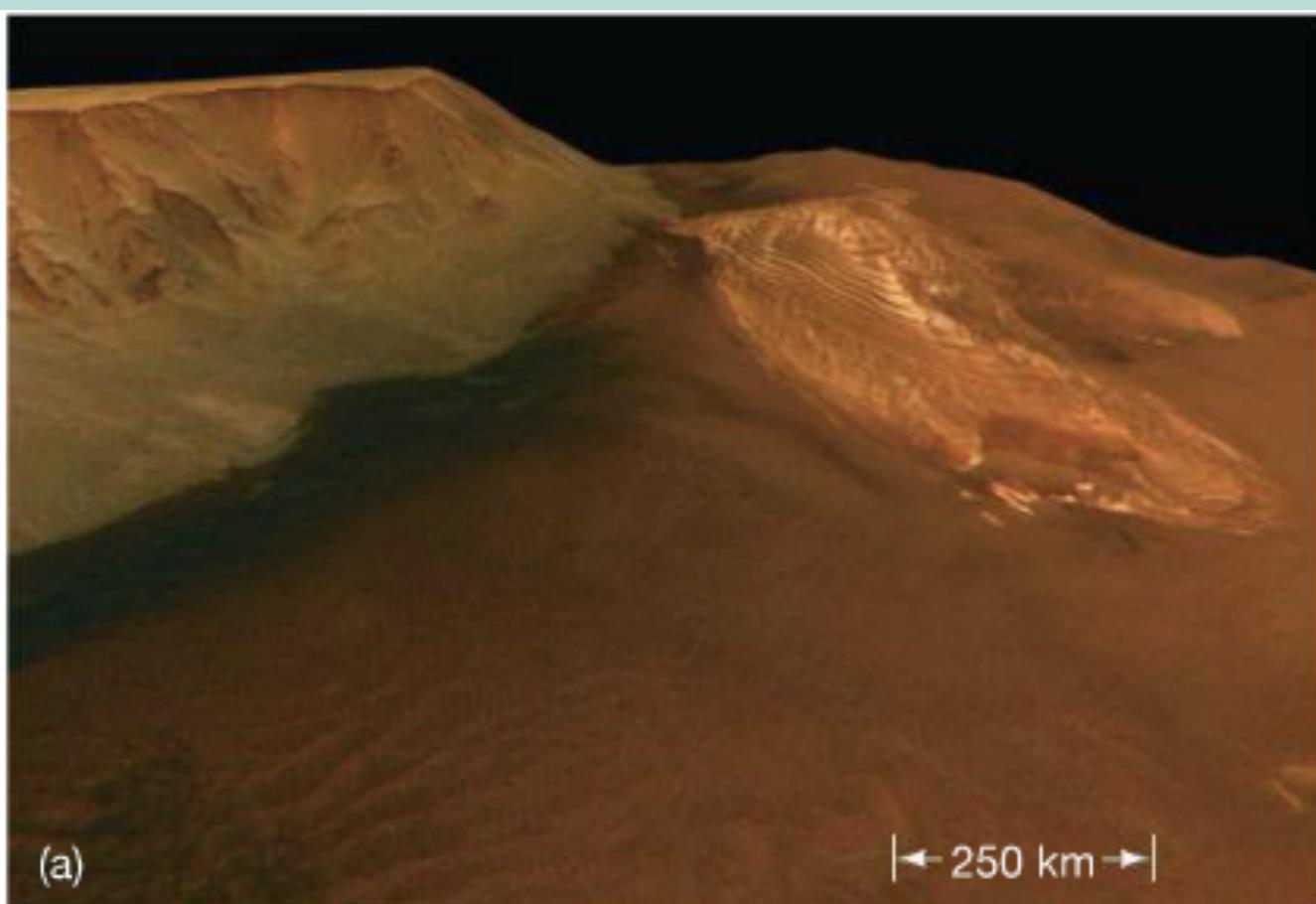
Alps, Orbit (Earth) and Orbit (Mars)

Mars: Ch 10



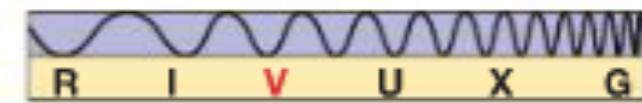
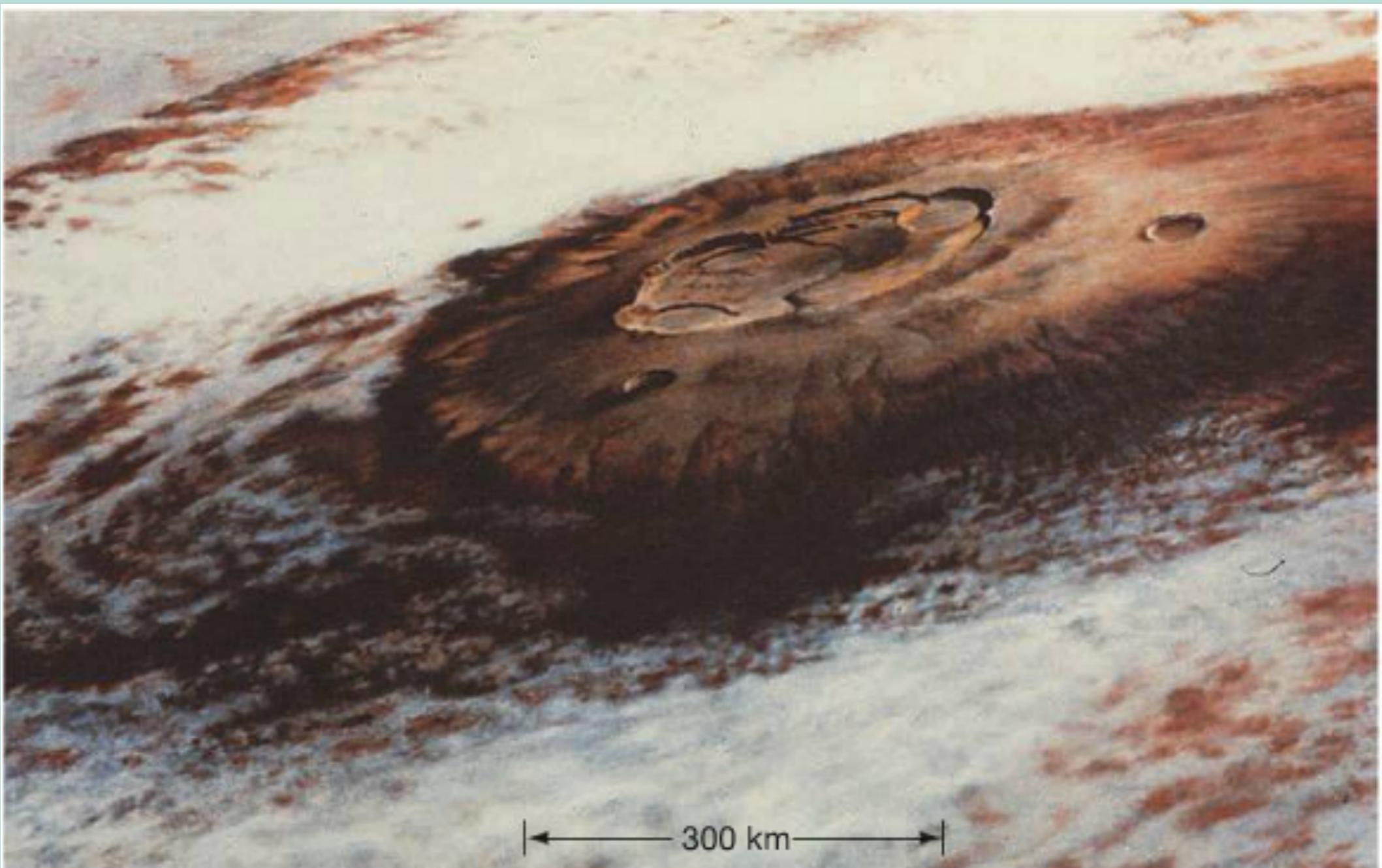
High Resolution Mosaic with Labeled Martian Features

Rolling volcanic planes (North vs South)

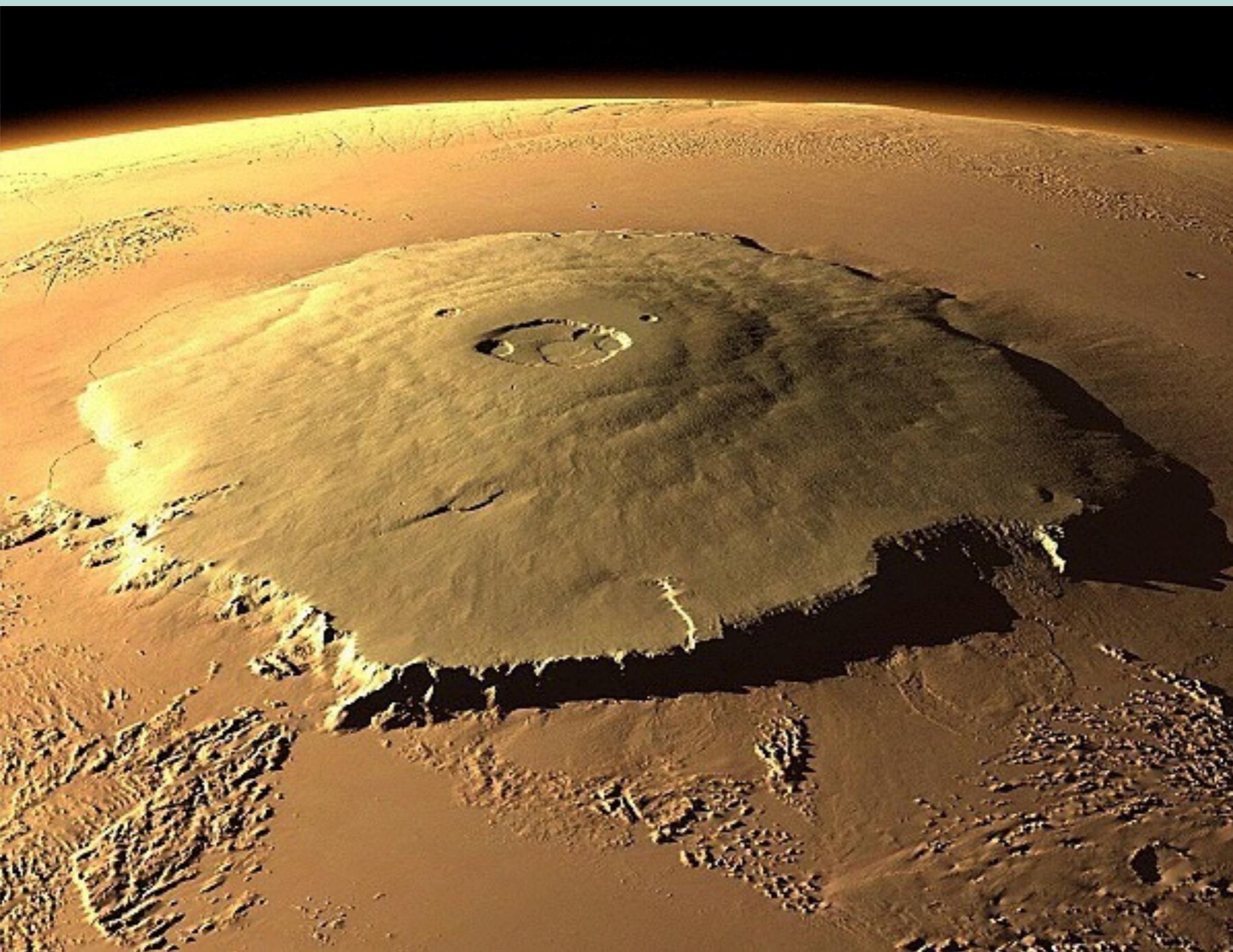


Mars: Ch 10

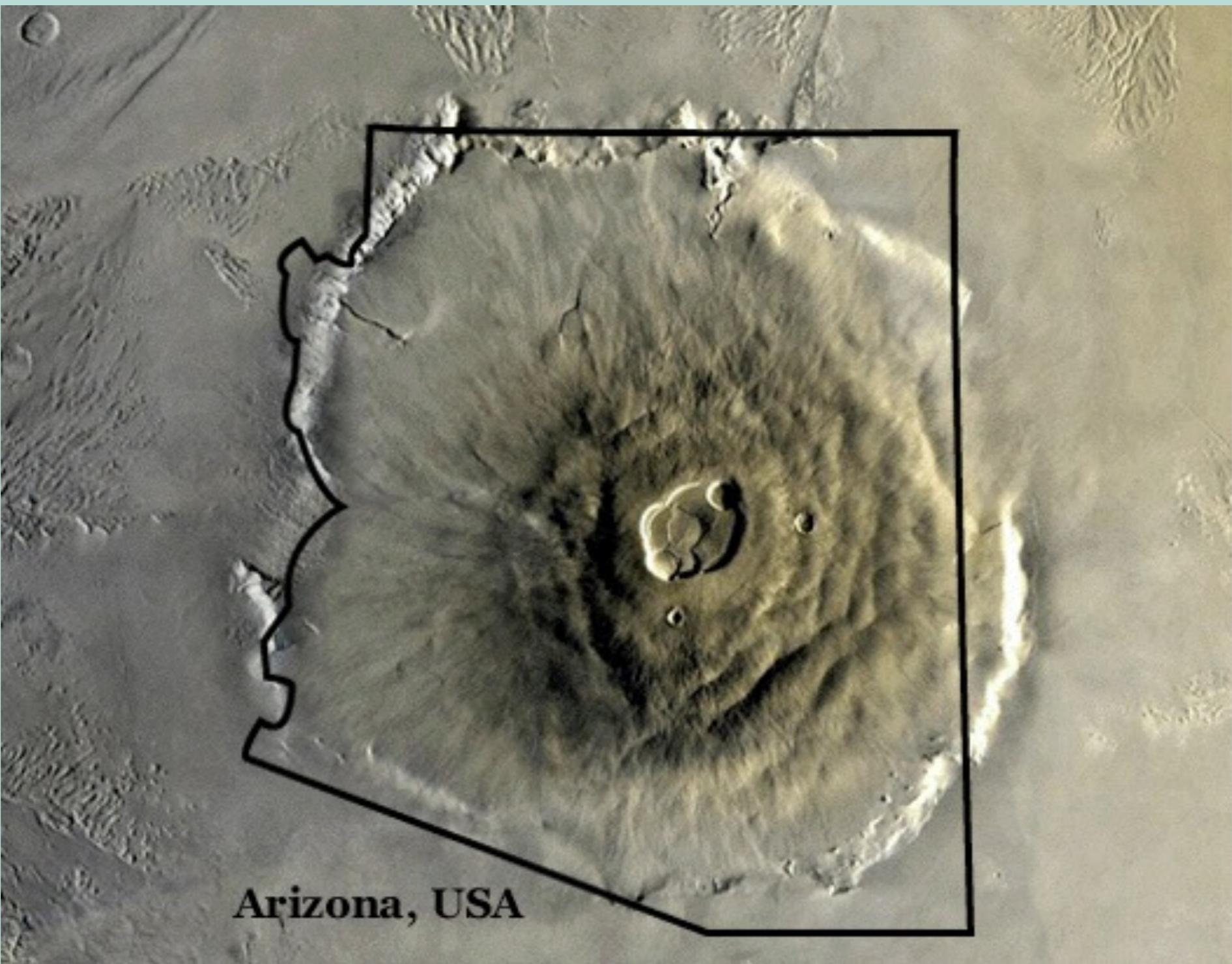
Olympus Mons



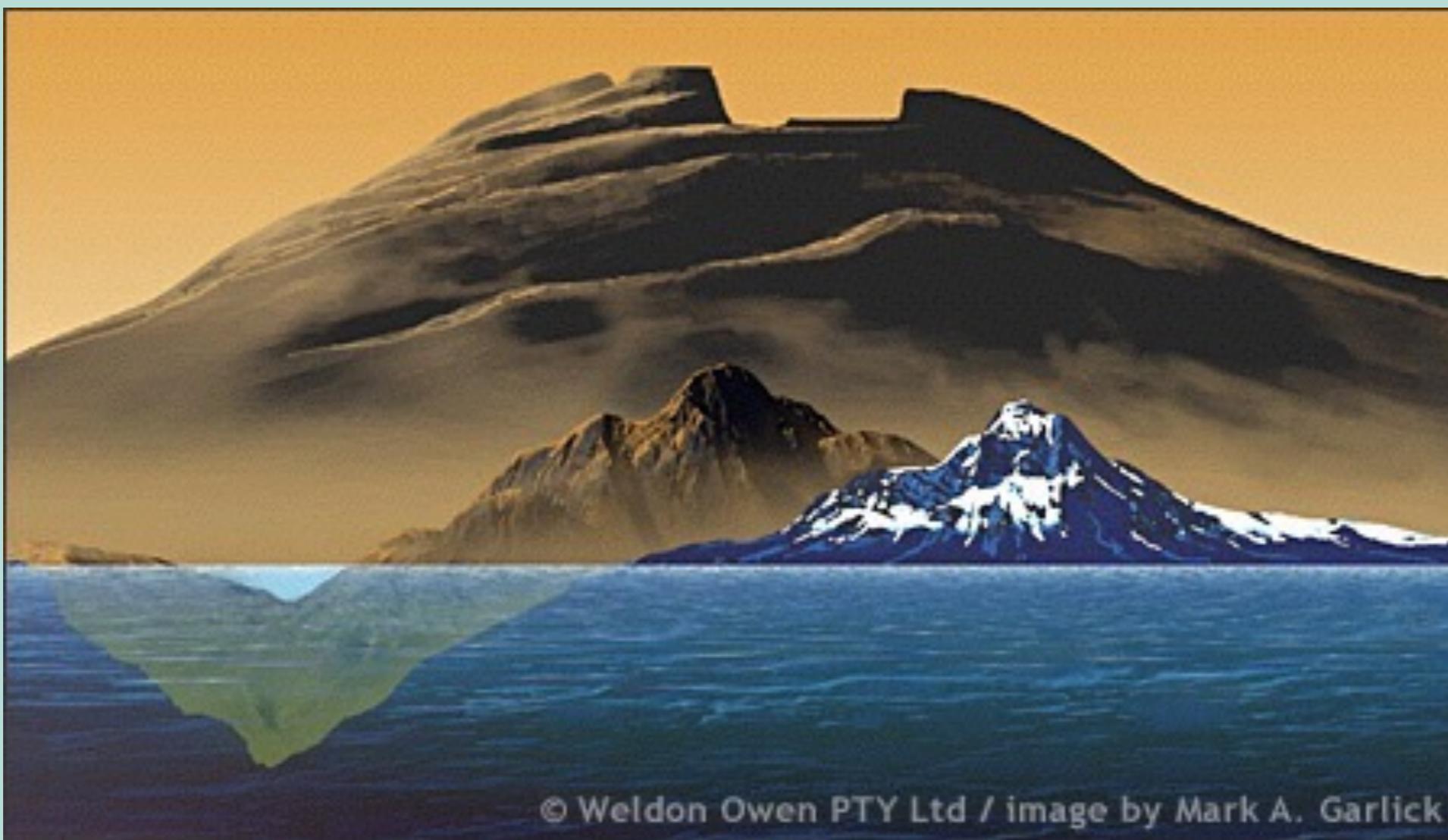
Mars: Ch 10



Mars: Ch 10



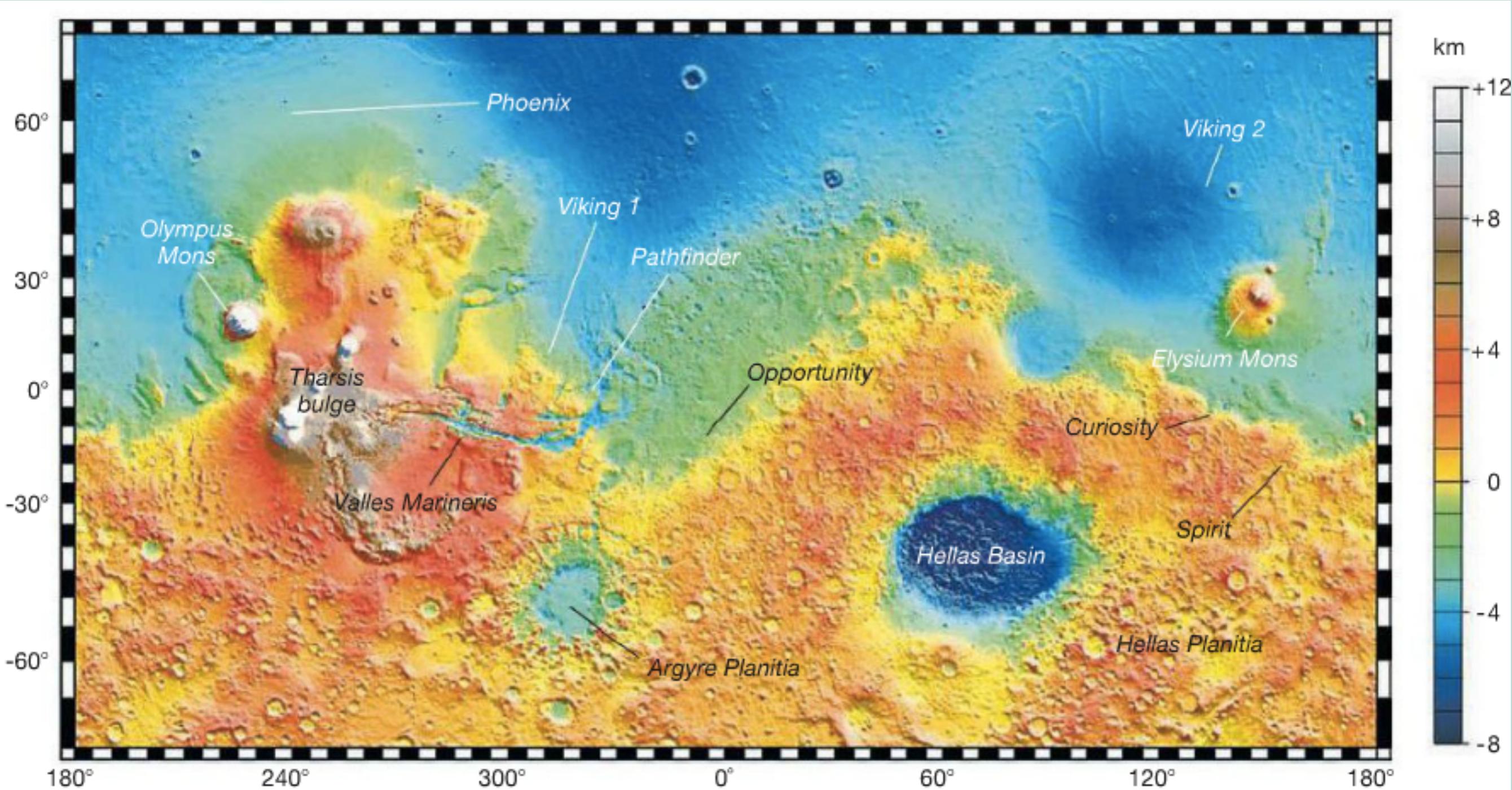
Mars: Ch 10



© Weldon Owen PTY Ltd / image by Mark A. Garlick

Mars: Ch 10

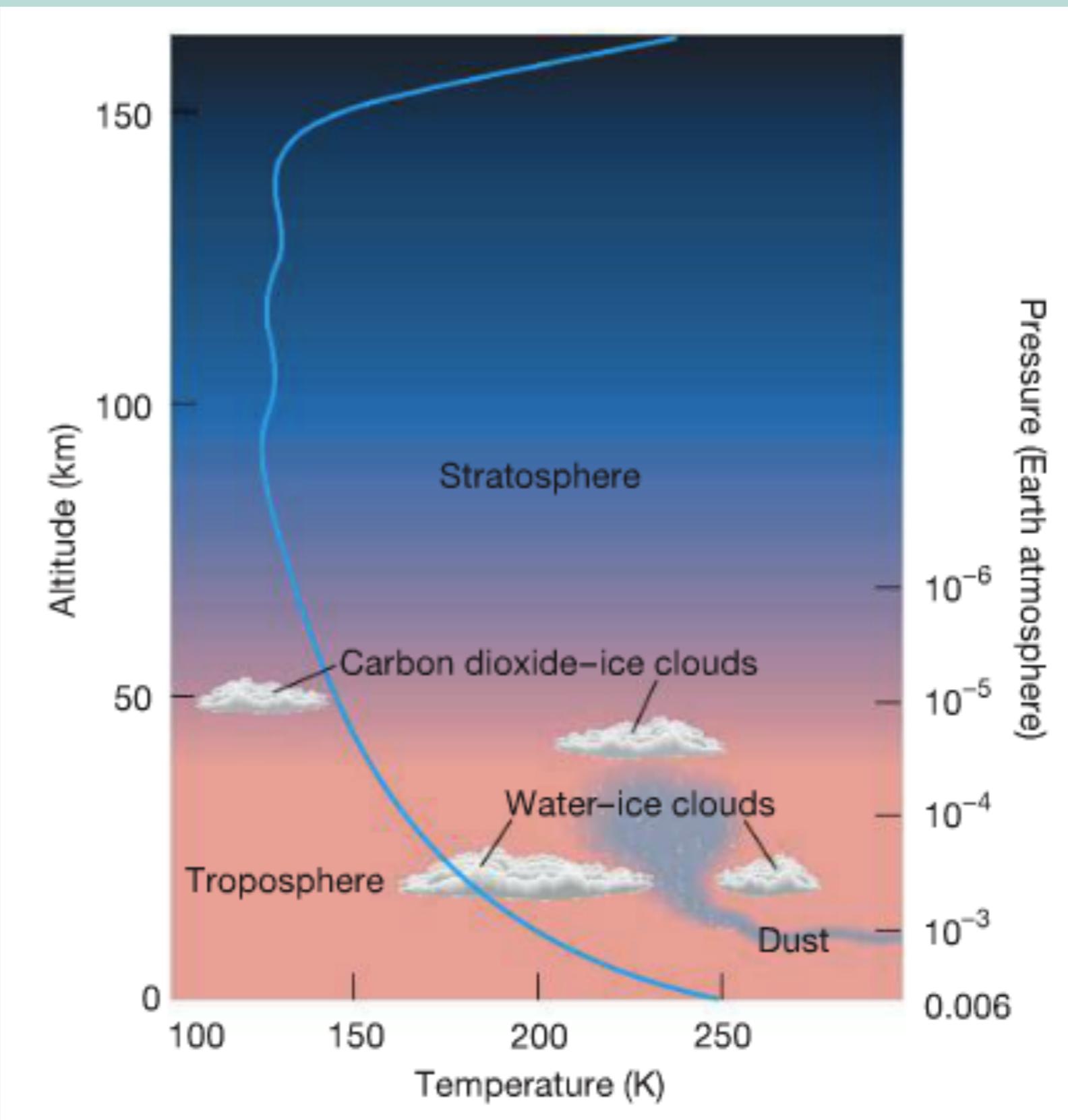
- * Height of a shield volcano determined by surface gravity
- * Maxwell Mons and Mauna Kea are same height for this reason
- * Mars' surface gravity is 40% less than earth, so volcanoes rise 2.5 times as high



Mars: Ch 10

- * Hellas Basin: lowest point, impact crater
- * Tharsis Bulge: highest point, martian ‘continent’
- * Borealis basin is due to a meteor impact, largest event in solar system, 2000km across (twice as big as Ceres) hitting at glancing angle, helps explain north/south difference

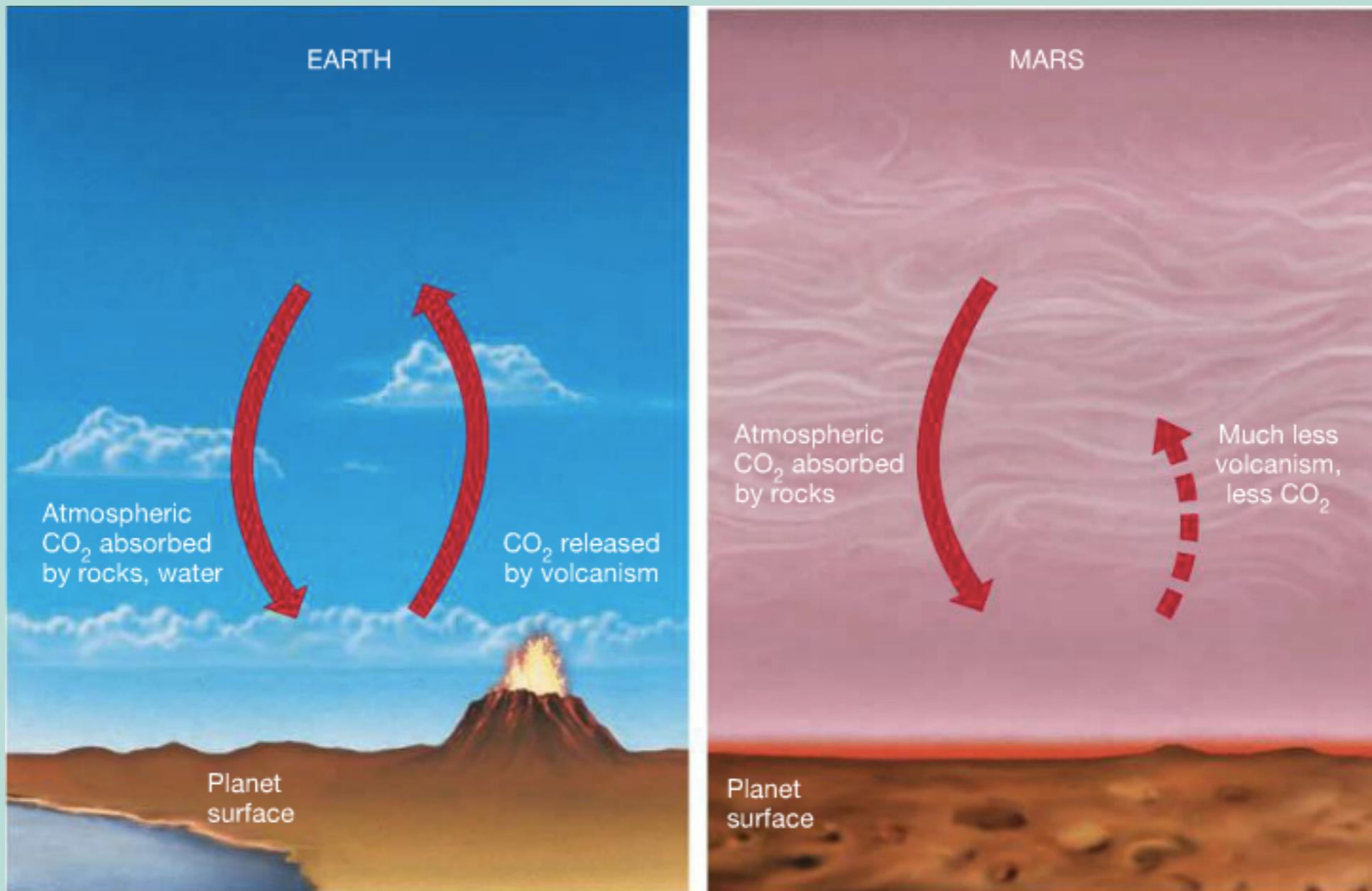
Martian Atmosphere



Mars: Ch 10

- * 95% CO₂, 2.7% N, 1.6% Ar, trace O₂ and H₂O
- * Day-Night Temperature change ~ 100K during the summer
- * No magnetosphere (No liquid core)

Mars: Ch 10

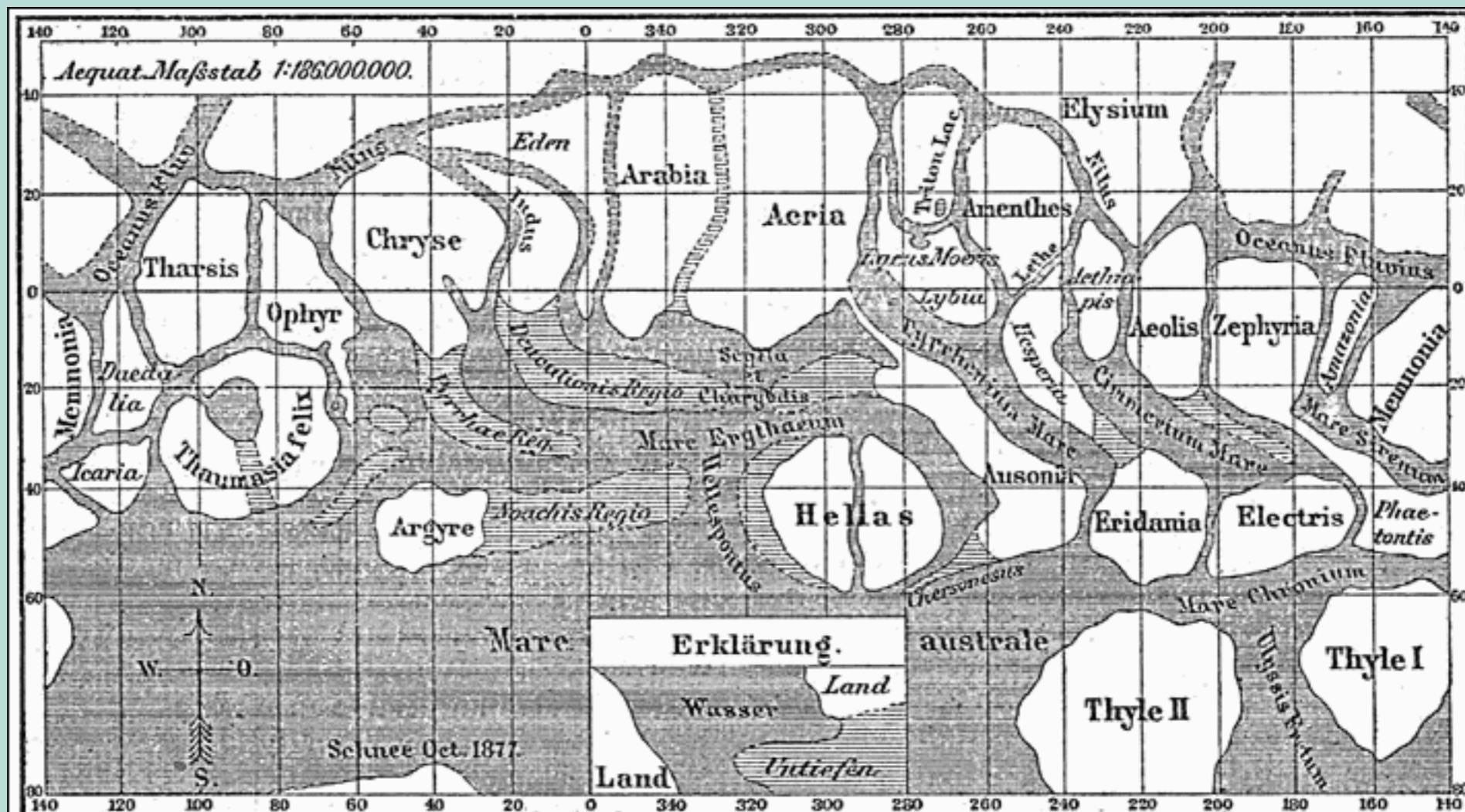


Mars: Ch 10

???



Mars: Ch 10



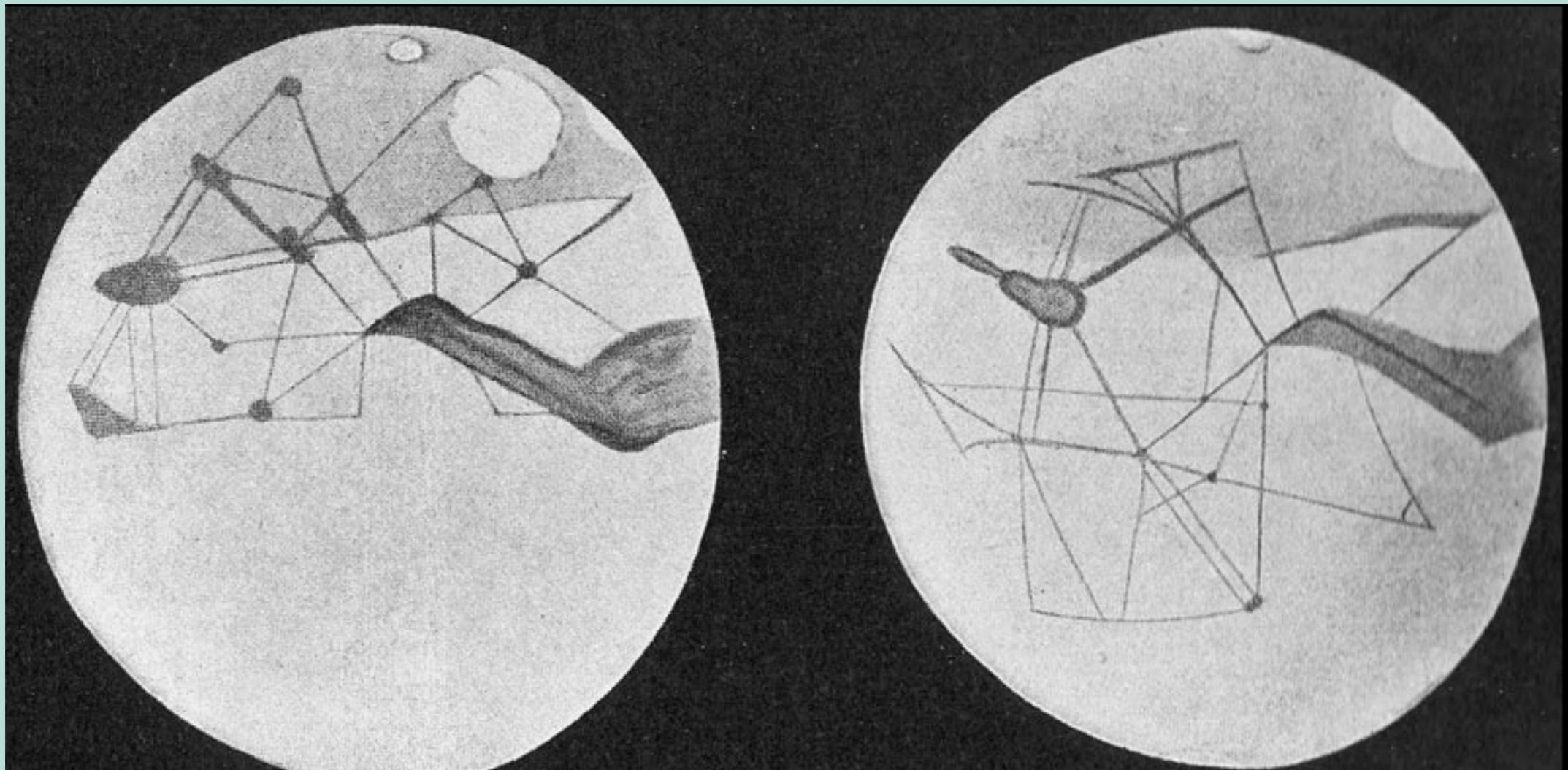
Giovanni Schiaparelli

Mars: Ch 10



Percival Lowell: 1855 - 1916. Boston, MA

Mars: Ch 10

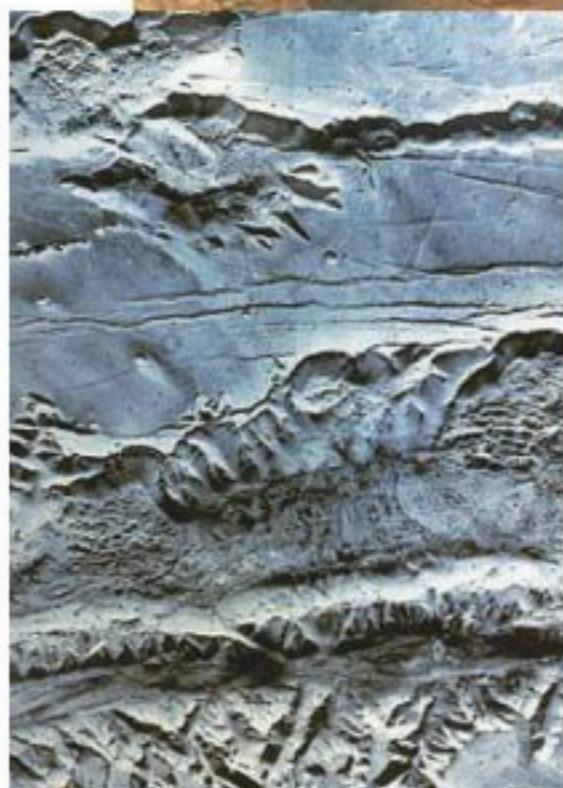


Mars: Ch 10

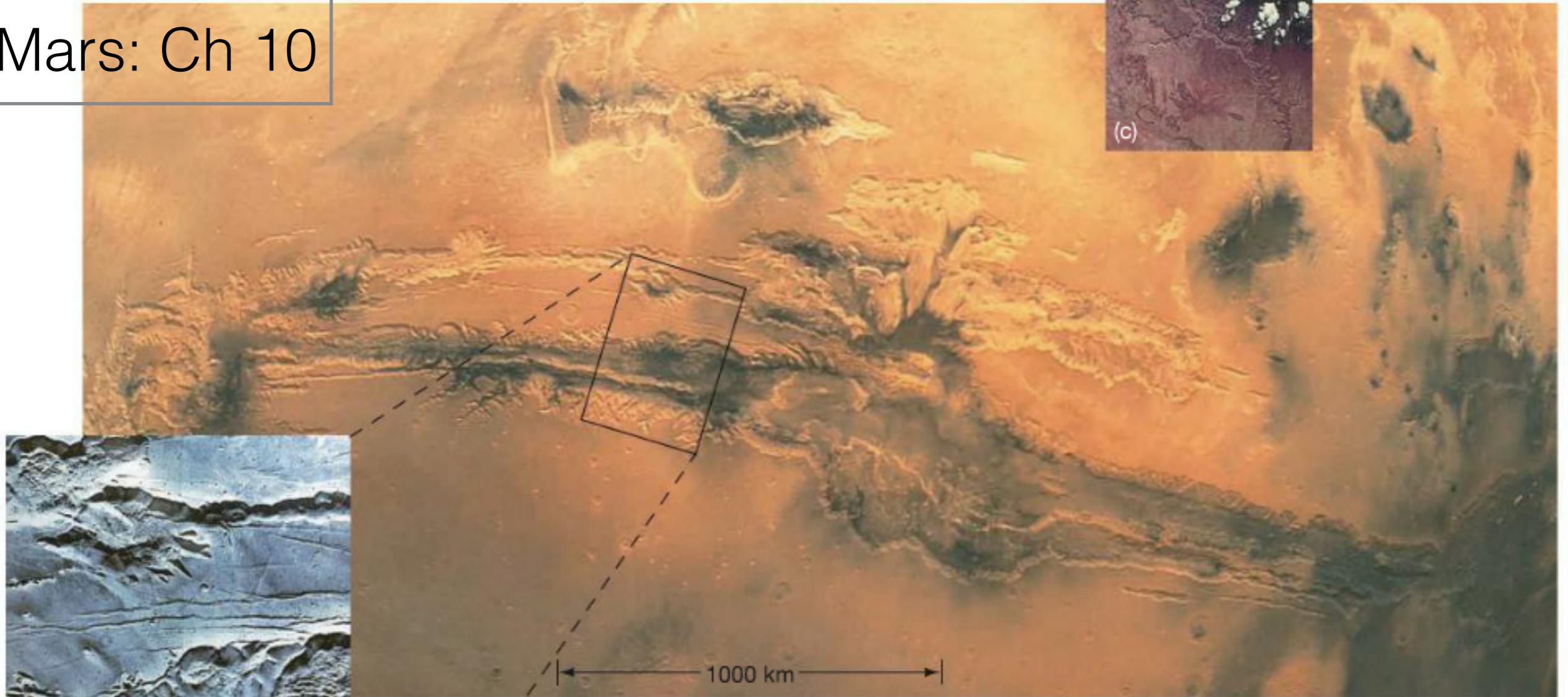
6 inch reflector mars



Mars: Ch 10



(b)



(a)

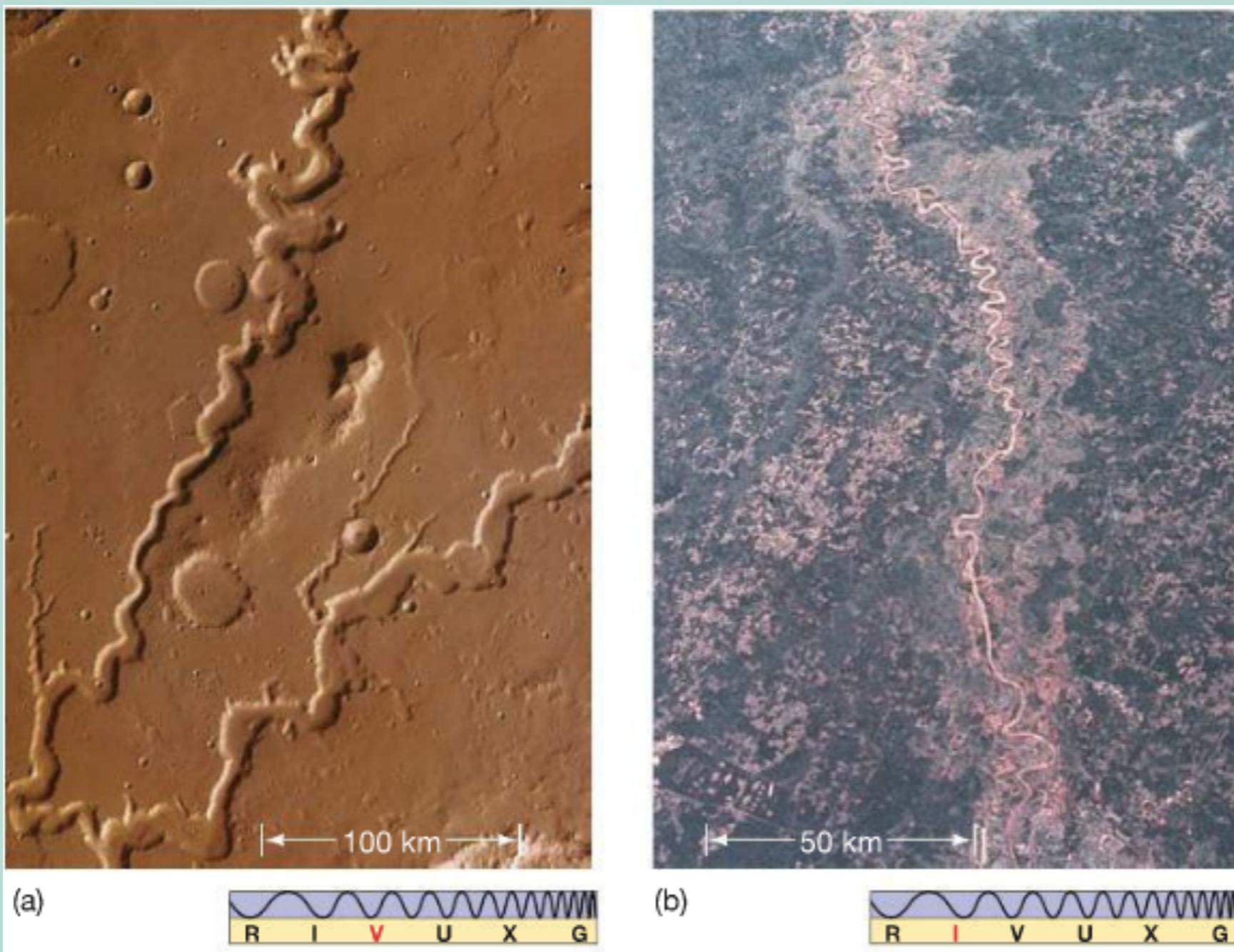
▲ FIGURE 10.6 Valles Marineris (a) The Mariner Valley is a huge canyon, 120 km wide and 7 km deep. Its length is about 4000 km, or nearly the full breadth of the continental United States. (b) A close-up view shows the complexity of the valley walls and dry tributaries. (c) A comparison, to scale, with Earth's Grand Canyon, which is a mere 20 km wide and 2 km deep, suggests just how

The only ‘real’ canal

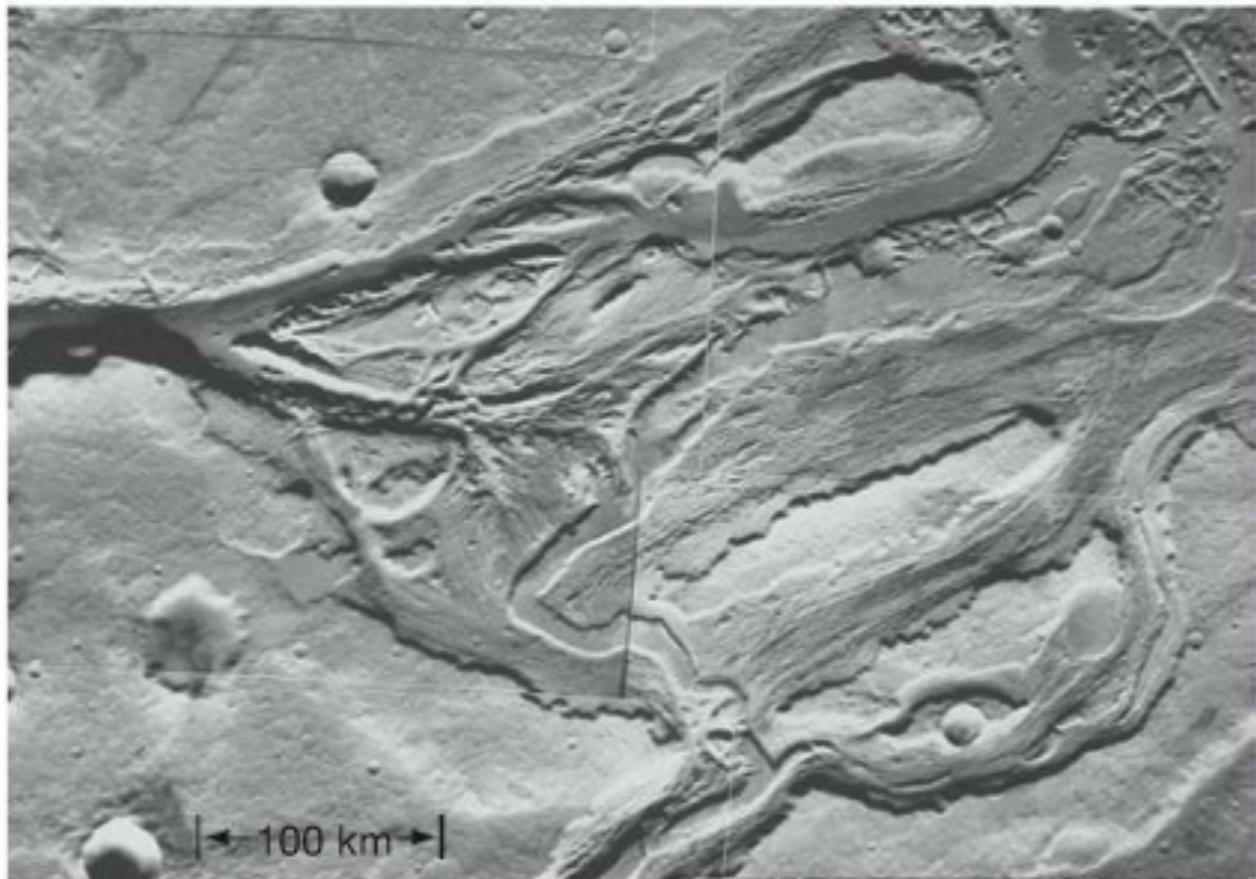
Valles Marineris

- * 4000 km across (1/5 of the way around the planet)
 - * 120 km maximum width, 7km max depth.

Martian vs American Run-off Channels



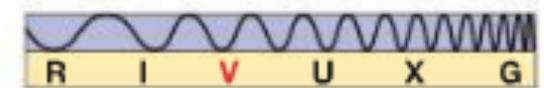
Martian Outflows



(a)



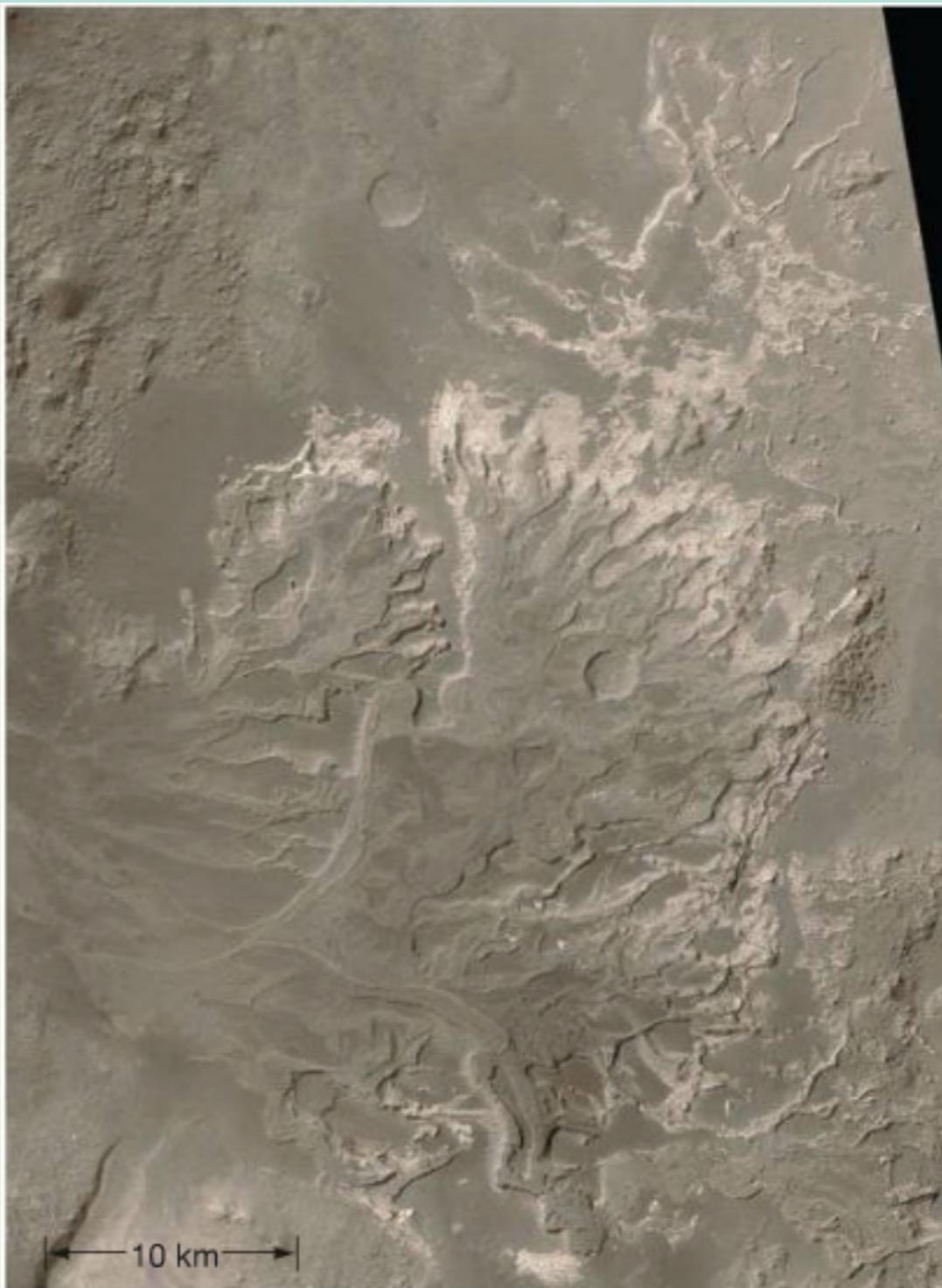
(b)



Tear shaped islands as floods rushed from the southern highlands to the northern plains

Mars: Ch 10

Martian River Delta

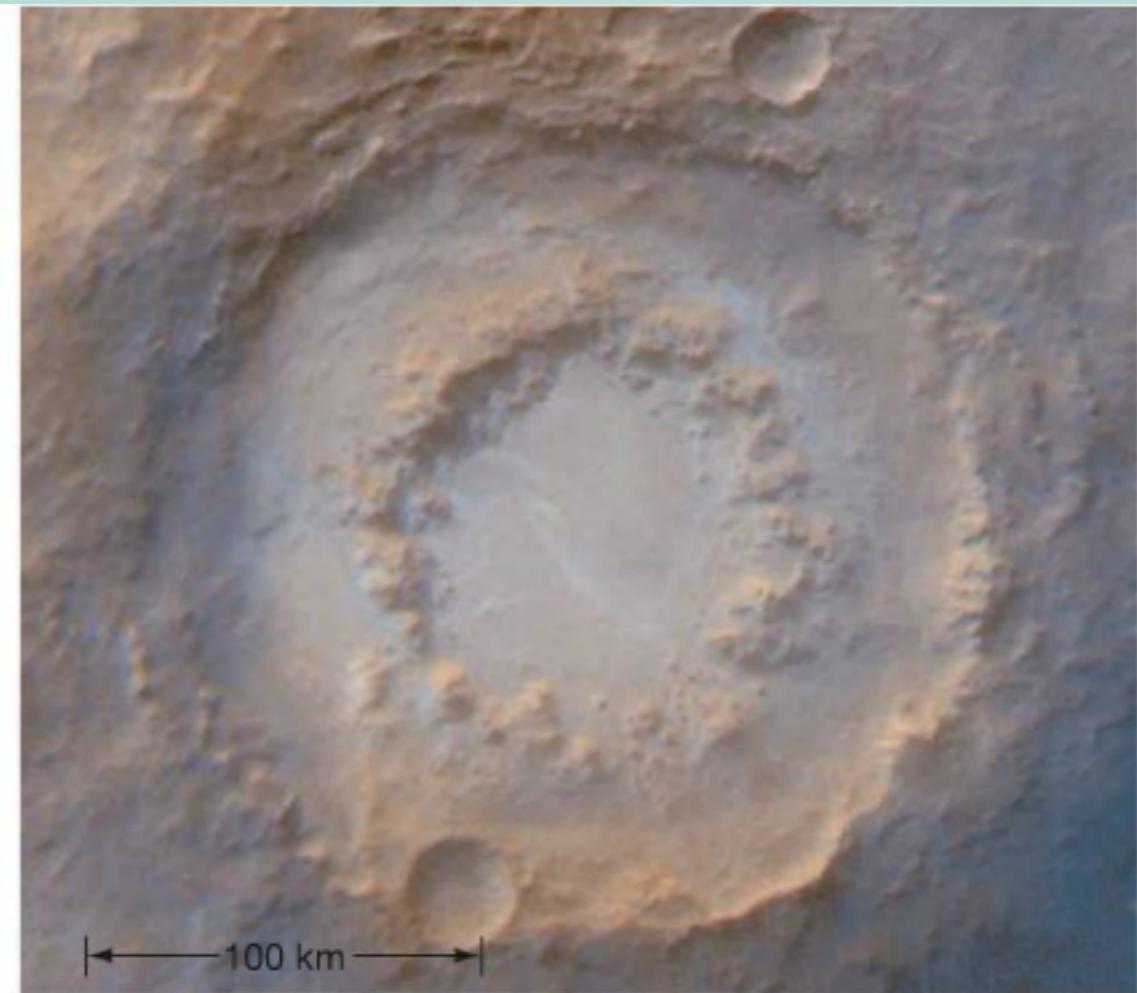


Mars: Ch 10

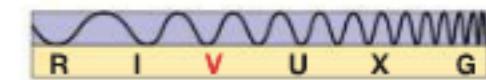
Fog



(a)

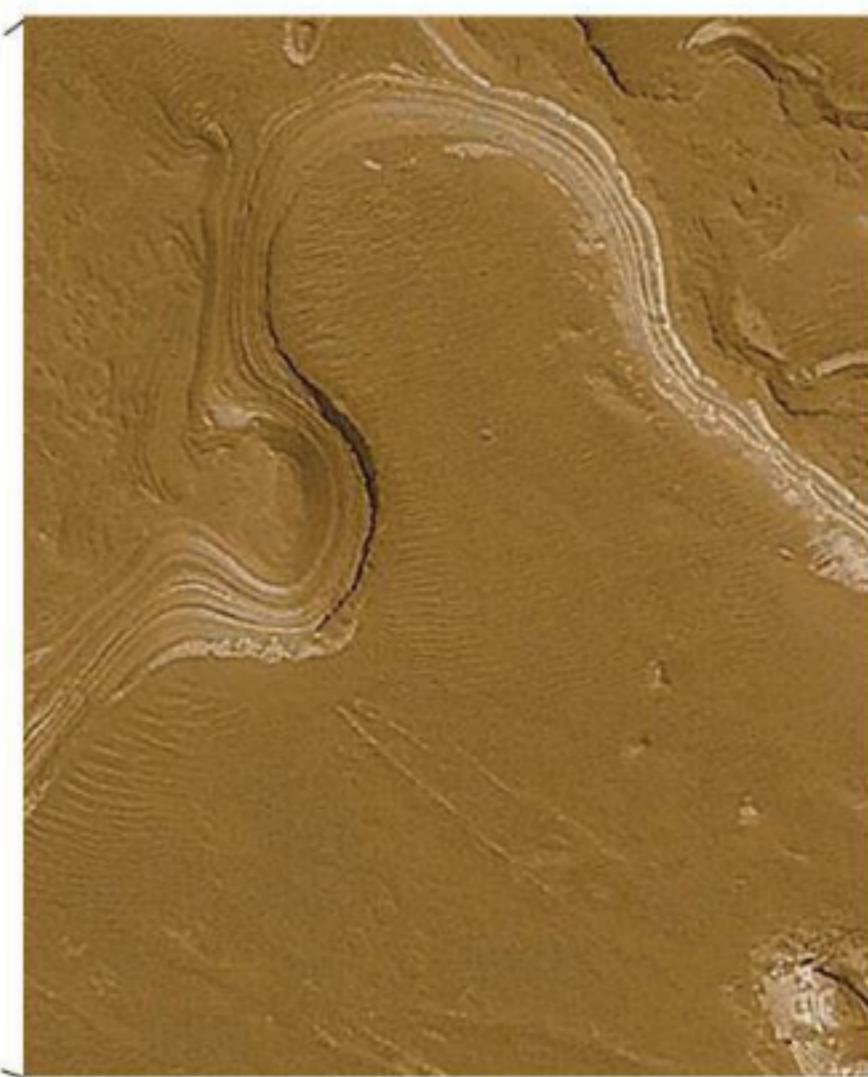
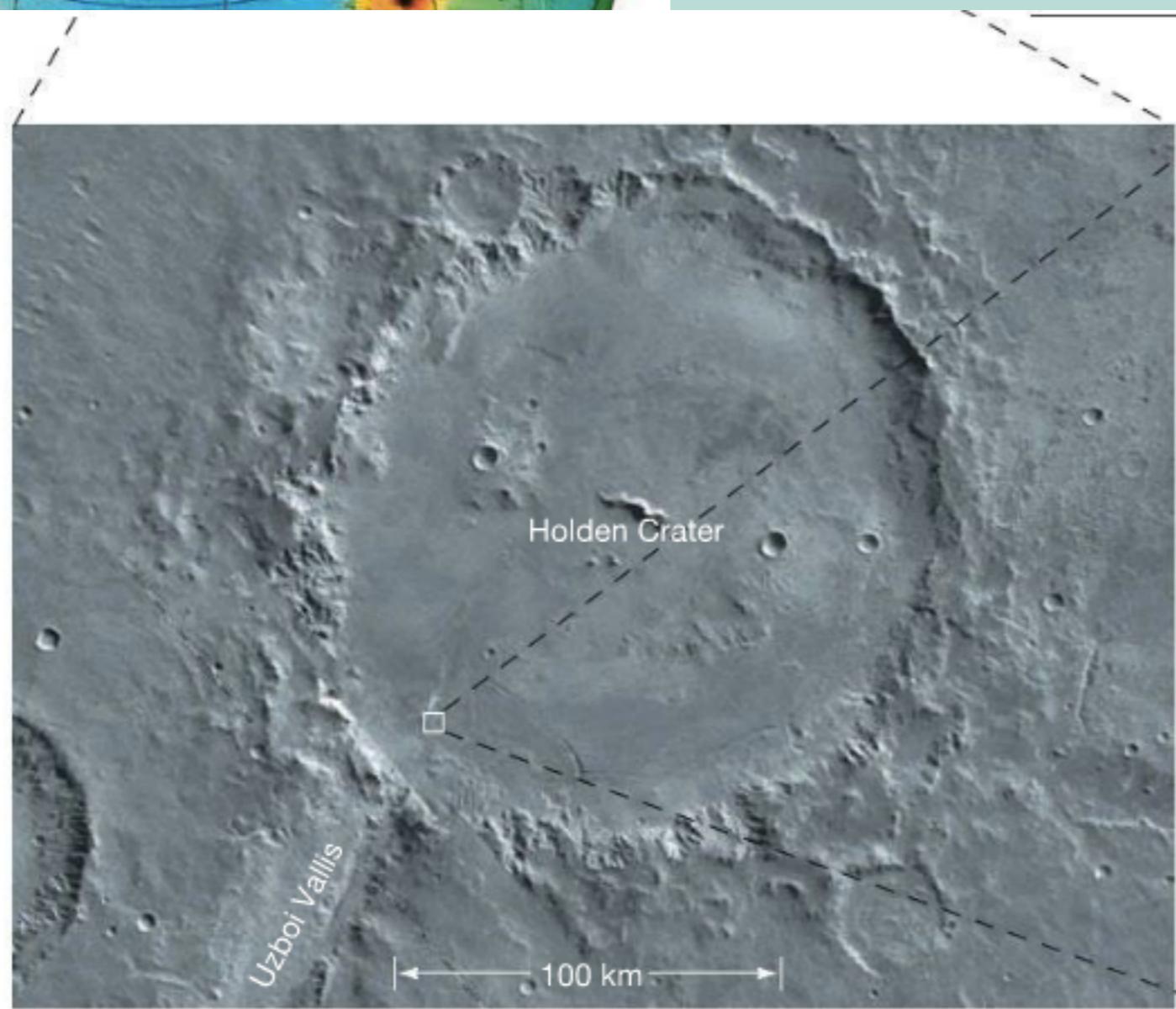
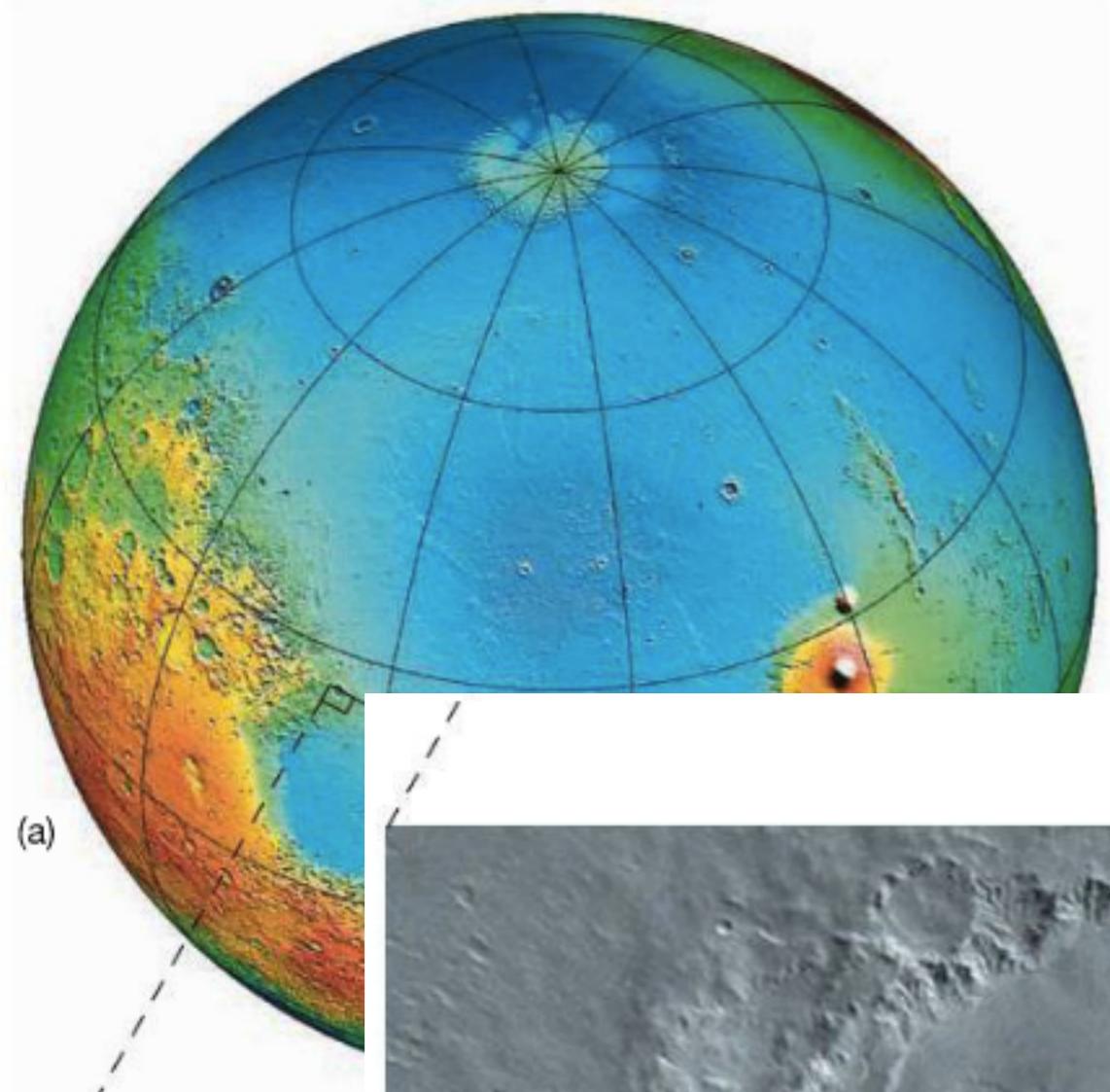


(b)



Mars: Ch 10

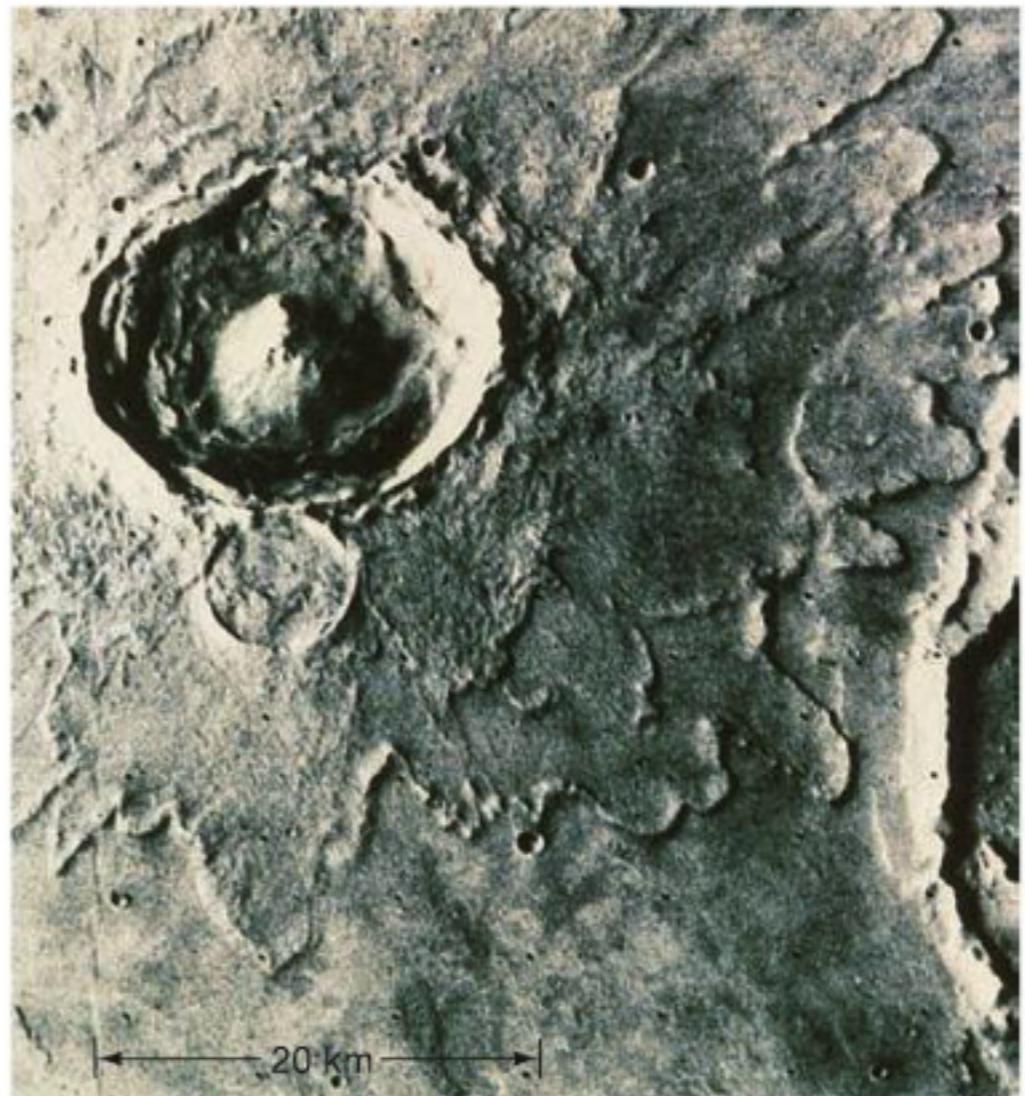
Ancient oceans



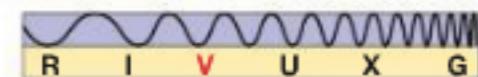
Mars crater vs Copernicus



(a)



(b)

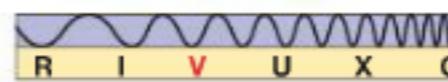
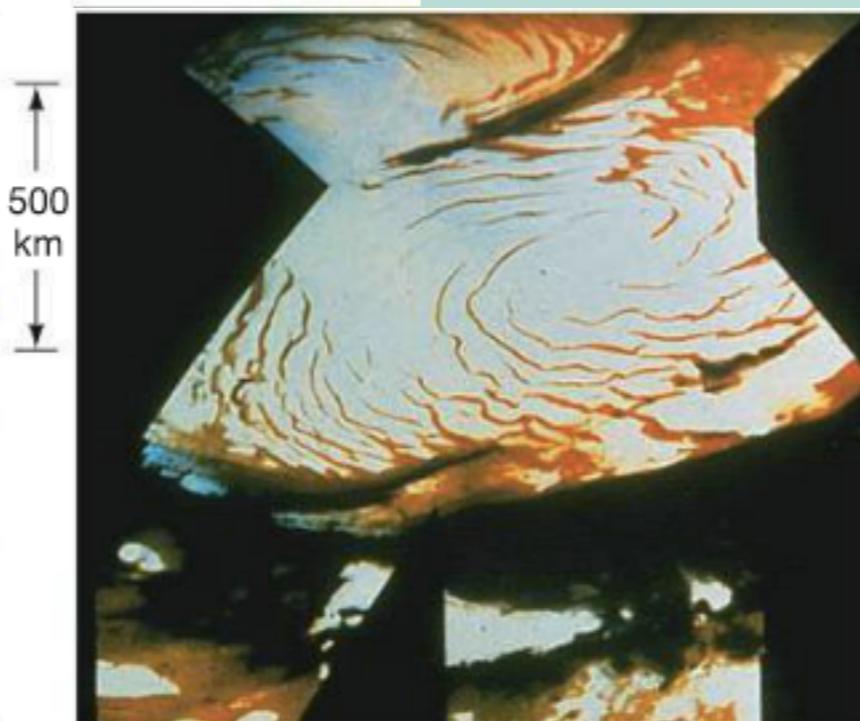


Subsurface ice (permafrost) exposed due to meteoric impact

Mars: Ch 10



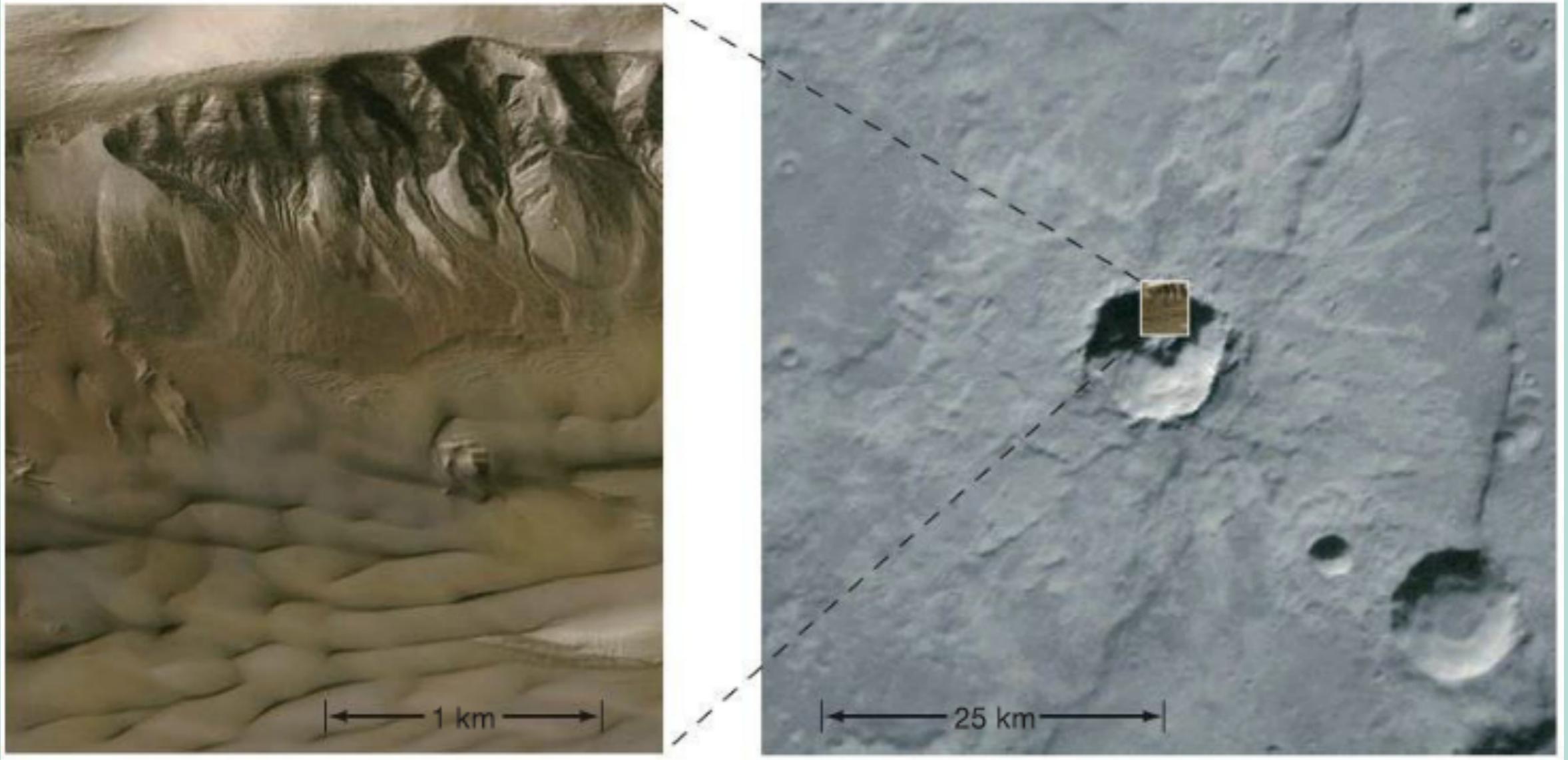
Residual Polar Caps



Mars: Ch 10

- * Southern Cap: 350 - 4000 km (mostly CO₂)
- * Northern Cap: 1000 - 3000 km (mostly H₂O)
- * Atmosphere varies by some 30% when caps melt in the summer
- * If this water became liquid, it could cover mars in 10m of water

Mars: Ch 10

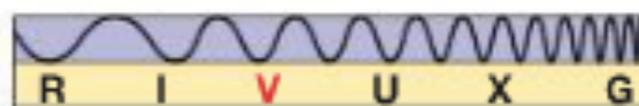


More recent gullies?

Mars: Ch 10



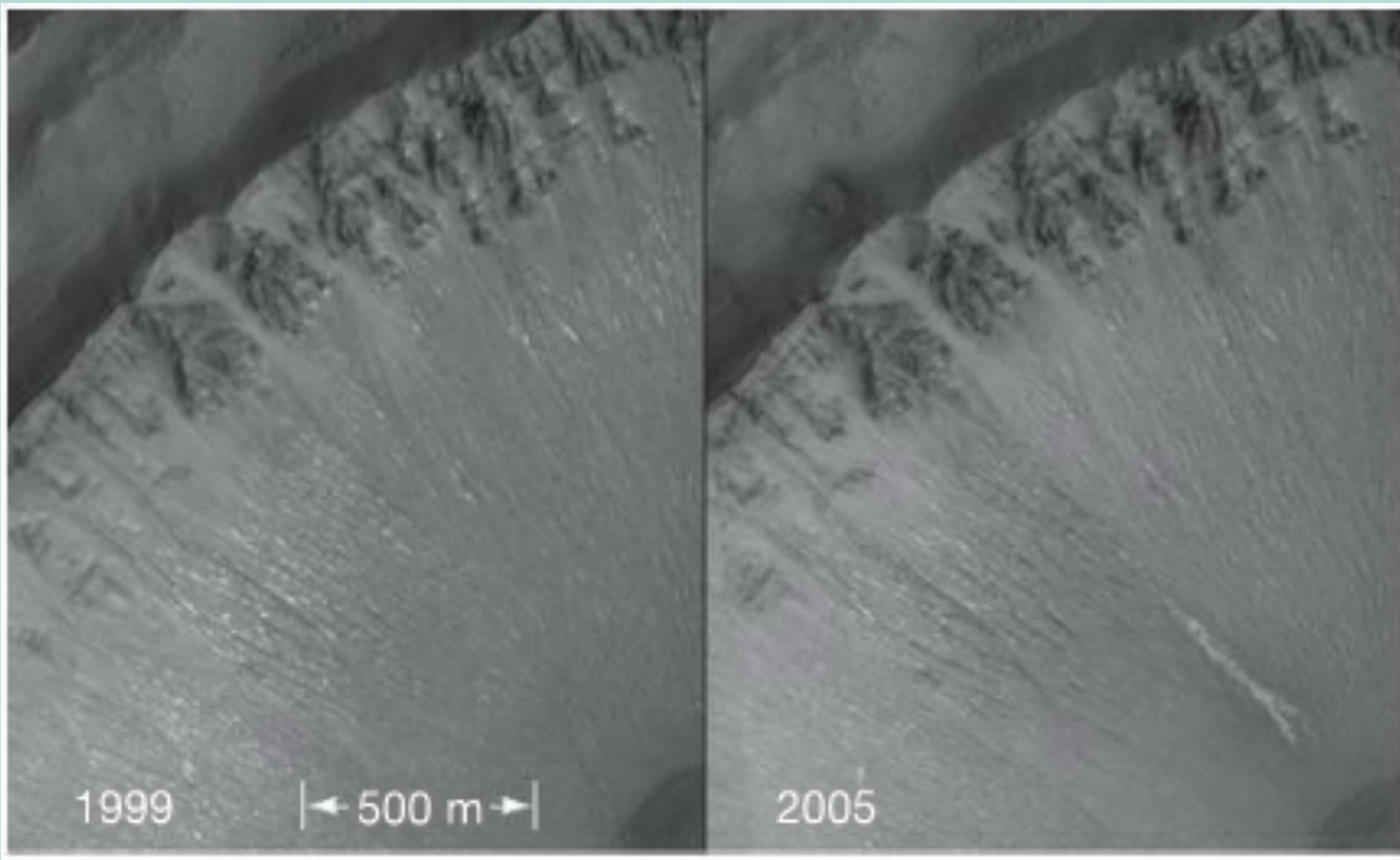
(b)



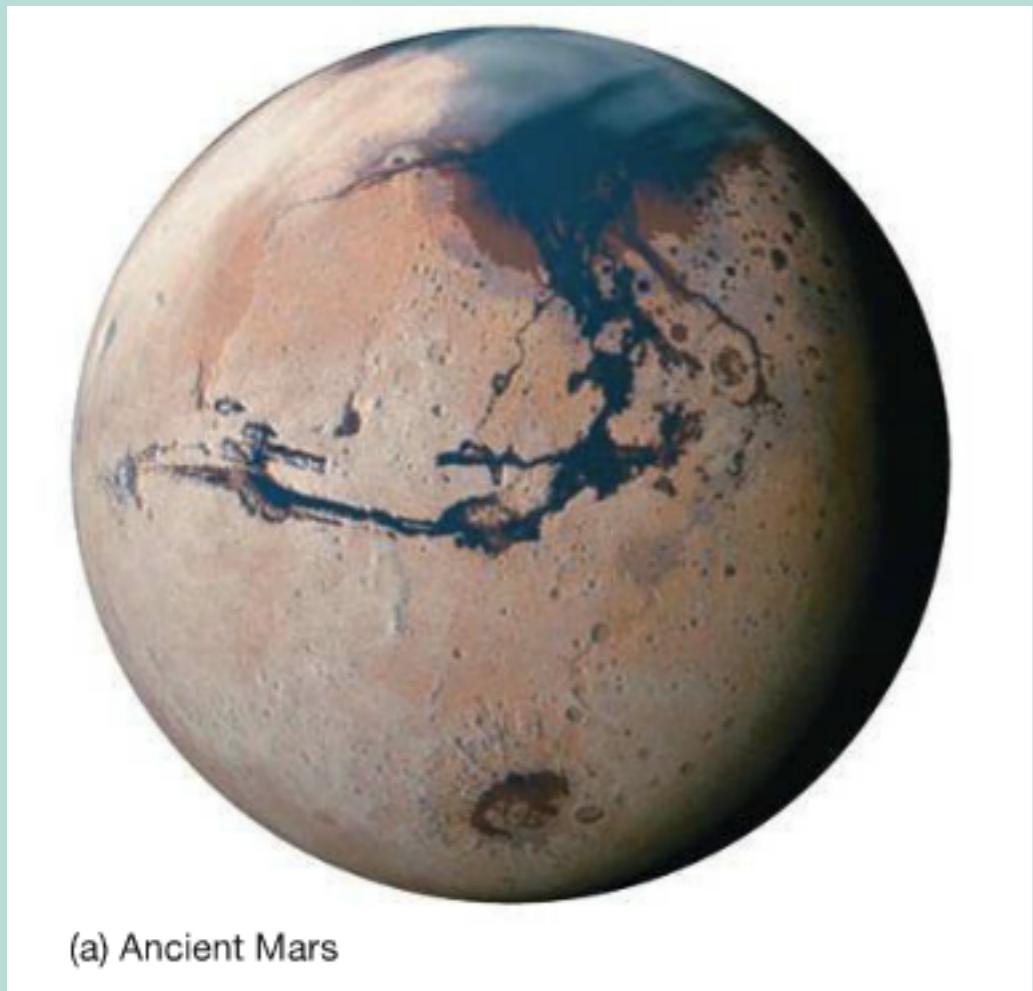
Haughton impact crater in the Arctic

Mars: Ch 10

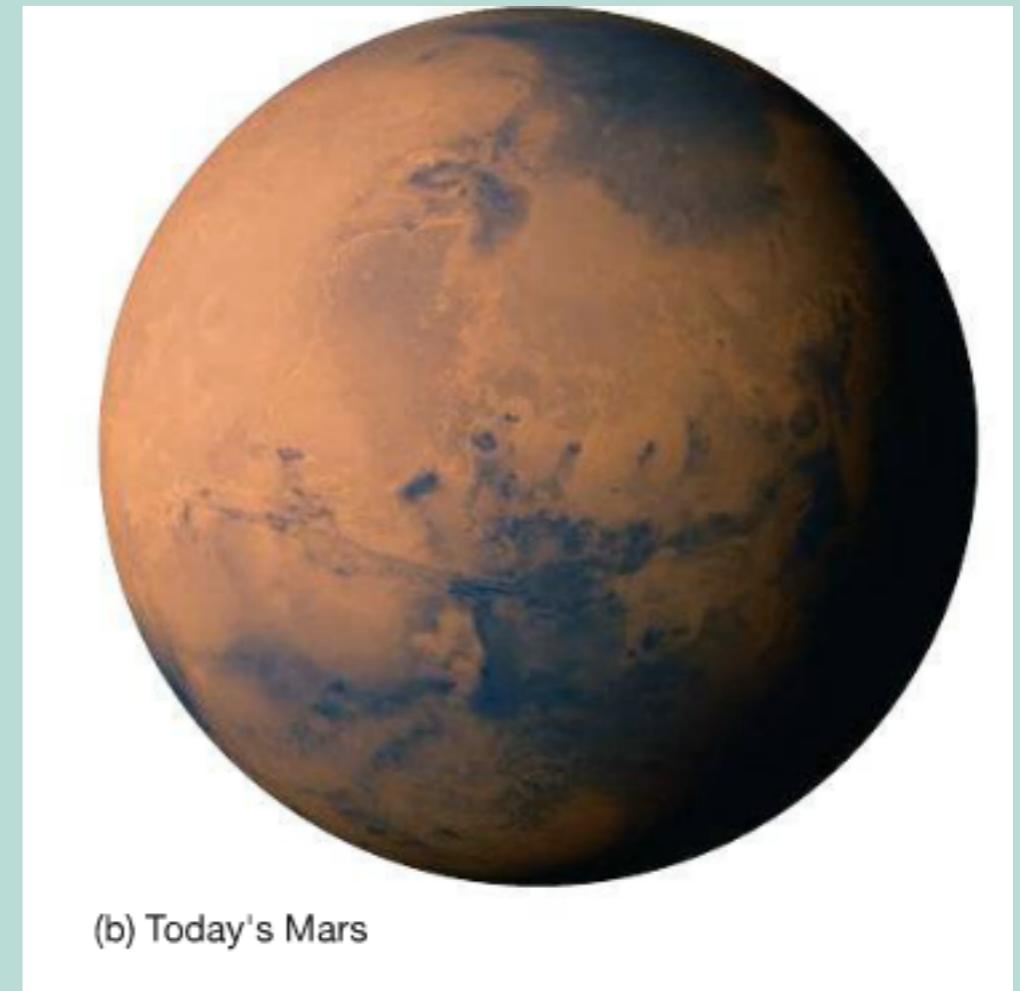
Recent Outflow?



Mars: Ch 10



(a) Ancient Mars



(b) Today's Mars

Atmosphere was 20 times denser 3.5 billion years ago

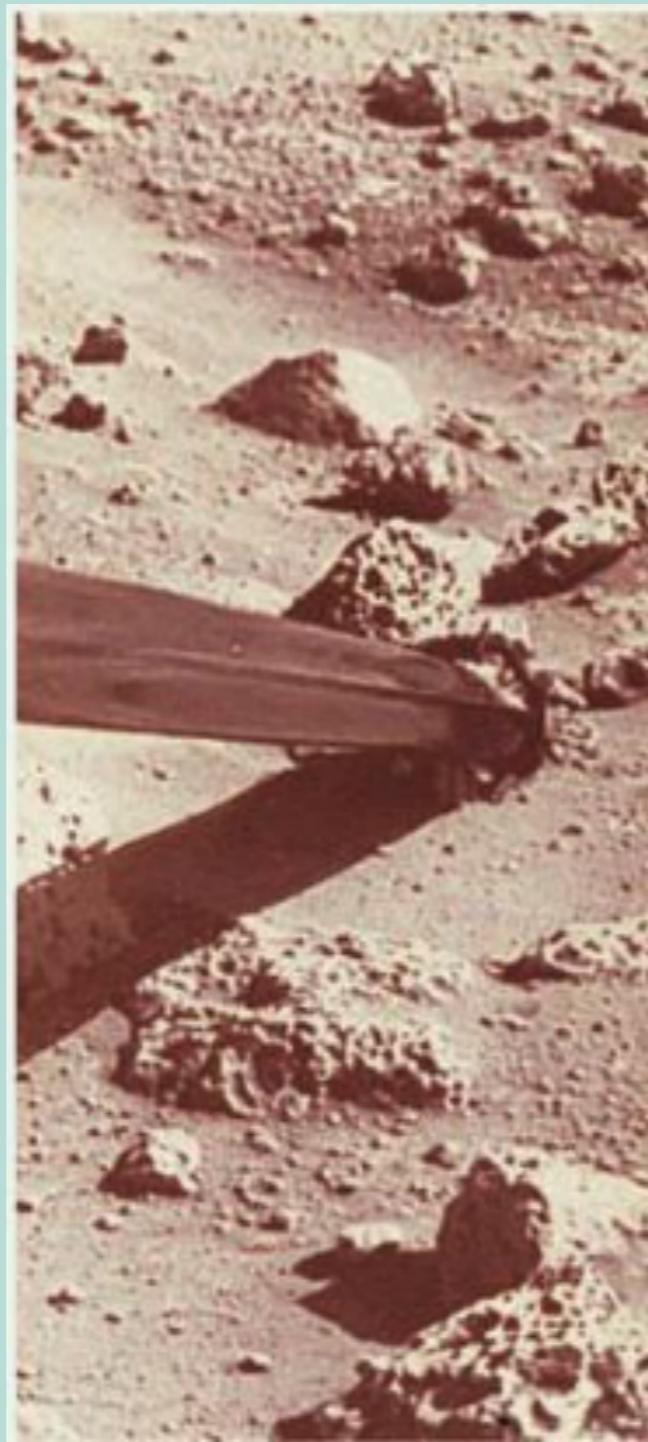
Mars: Ch 10

Life on Mars?



Mars: Ch 10

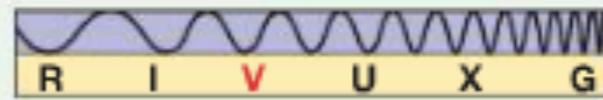
Microbe Probe



(Before)



(After)



Mars: Ch 10

- * Gas exchange: offer a nutrient broth and look for gases that signal metabolic activity
- * Label-Release: add compounds containing radioactive carbon to the soil and then wait for results signaling that Martian organisms had either eaten or inhaled the carbon.
- * Pyrolytic-Release: add radioactive carbon to soil and atmosphere, wait, remove the gas and test the soil by heating it.

Martian Meteor
1984 Antarctica

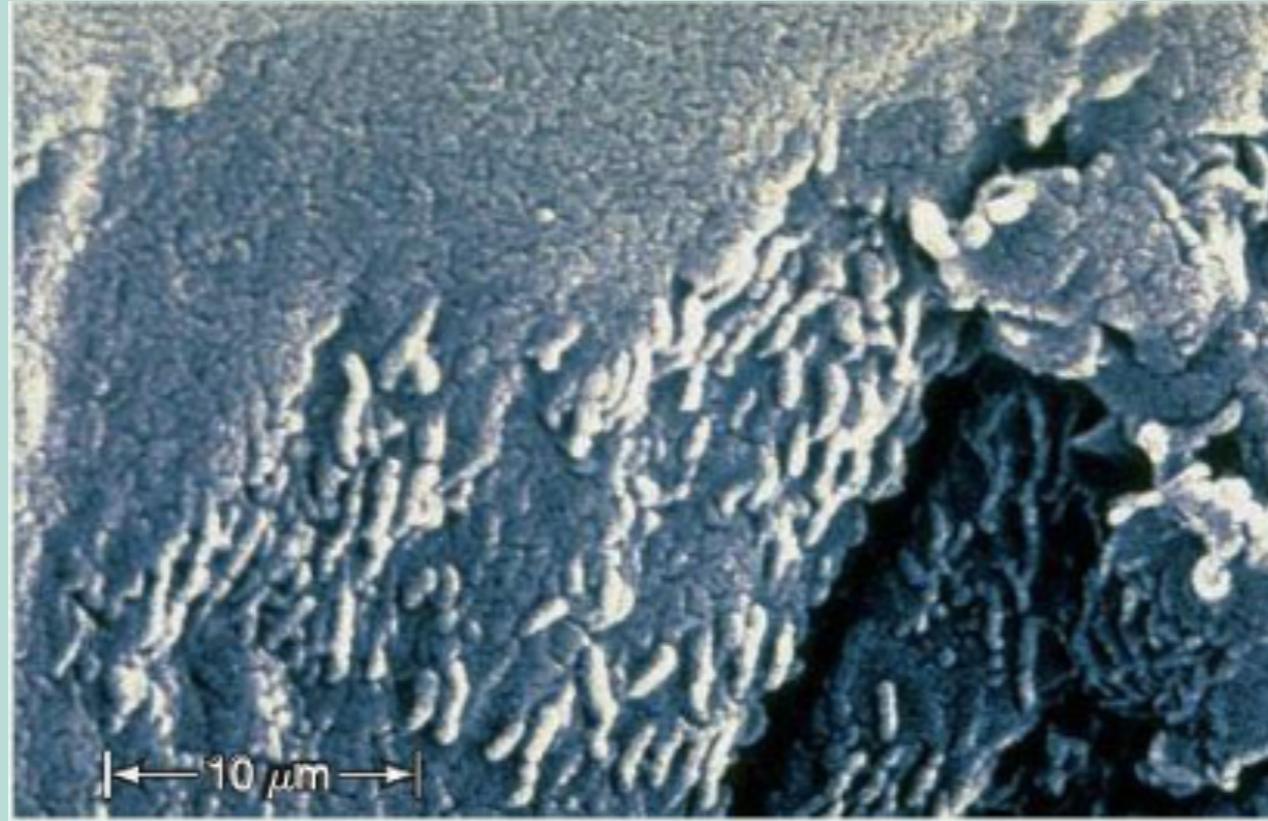


Globules of carbonate! Water present!

The Evidence

- * Bacteria on Earth produce globules like these
- * The meteorite contains PAHs
- * The meteorite contains time teardrop-shaped crystals of magnetite and iron sulfide embedded in places where the carbonate has dissolved (bacteria tend to do that on earth)
- * Fossilized life?

Mars: Ch 10



Miniature fossils of martian organisms?? (30X smaller than similar bacteria found on earth)

-> none of this is conclusive... especially since the rock has been sitting in antarctica for 14000 years.



DISCUSSION

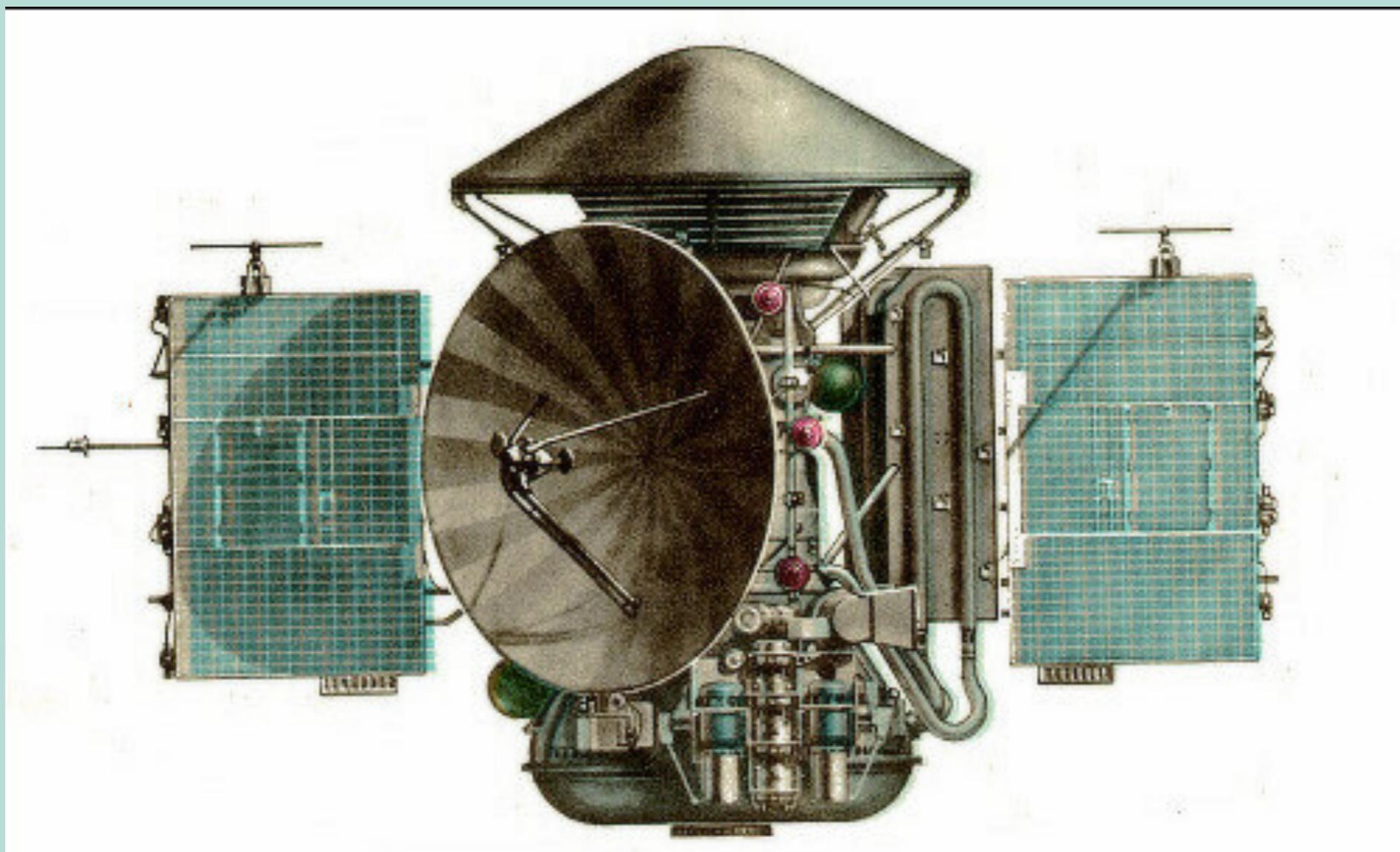
Mars: Ch 10

MarsBourne spacecraft



Mars: Ch 10

Mars 3 (USSR 1971)



Mars: Ch 10

Viking 1 (1976)

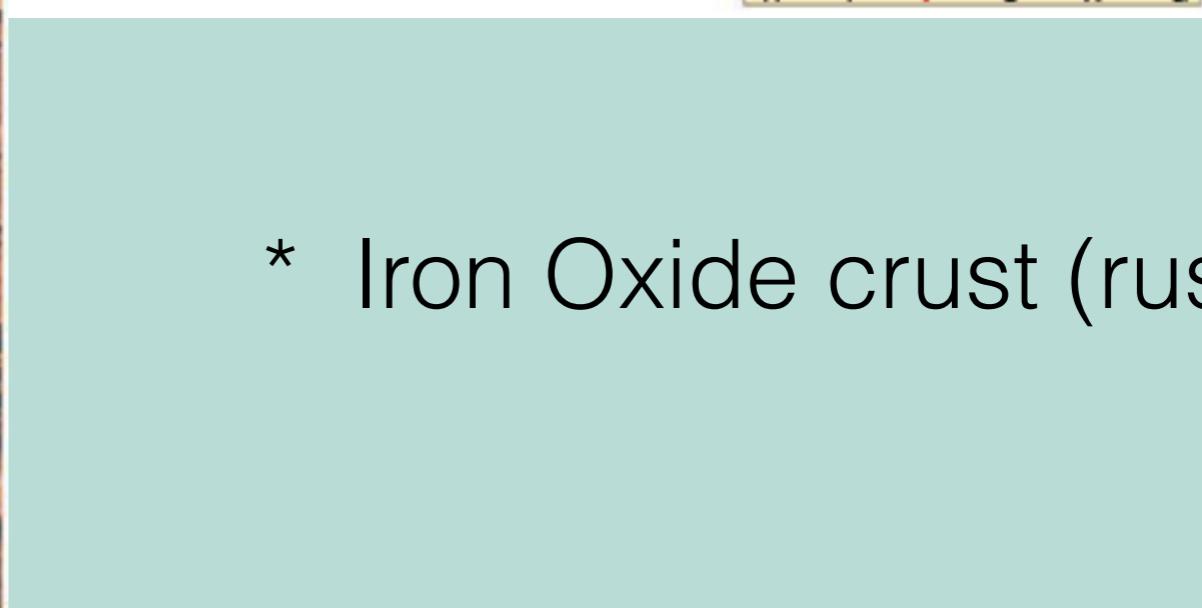
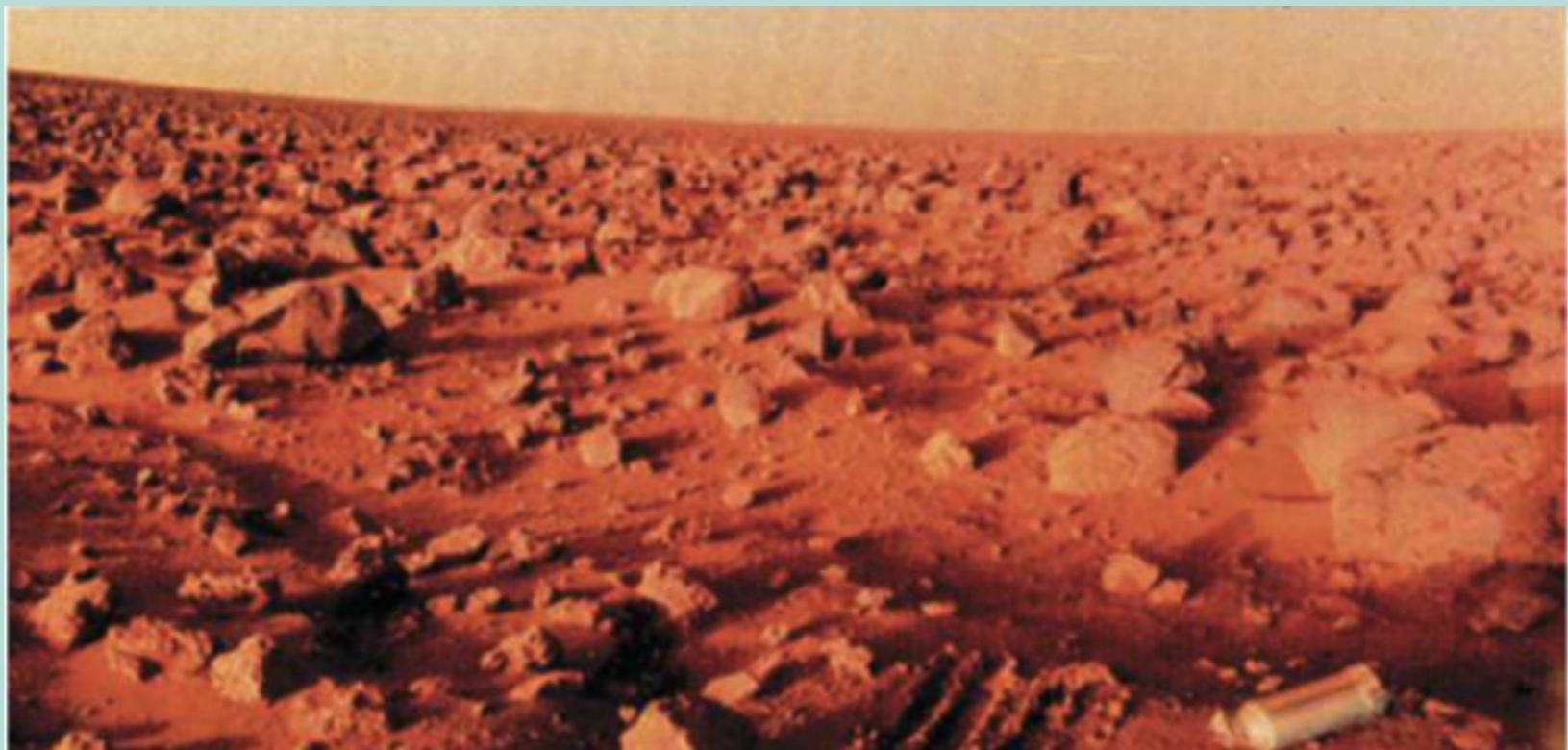


Mars: Ch 10

Viking 2 (1976)



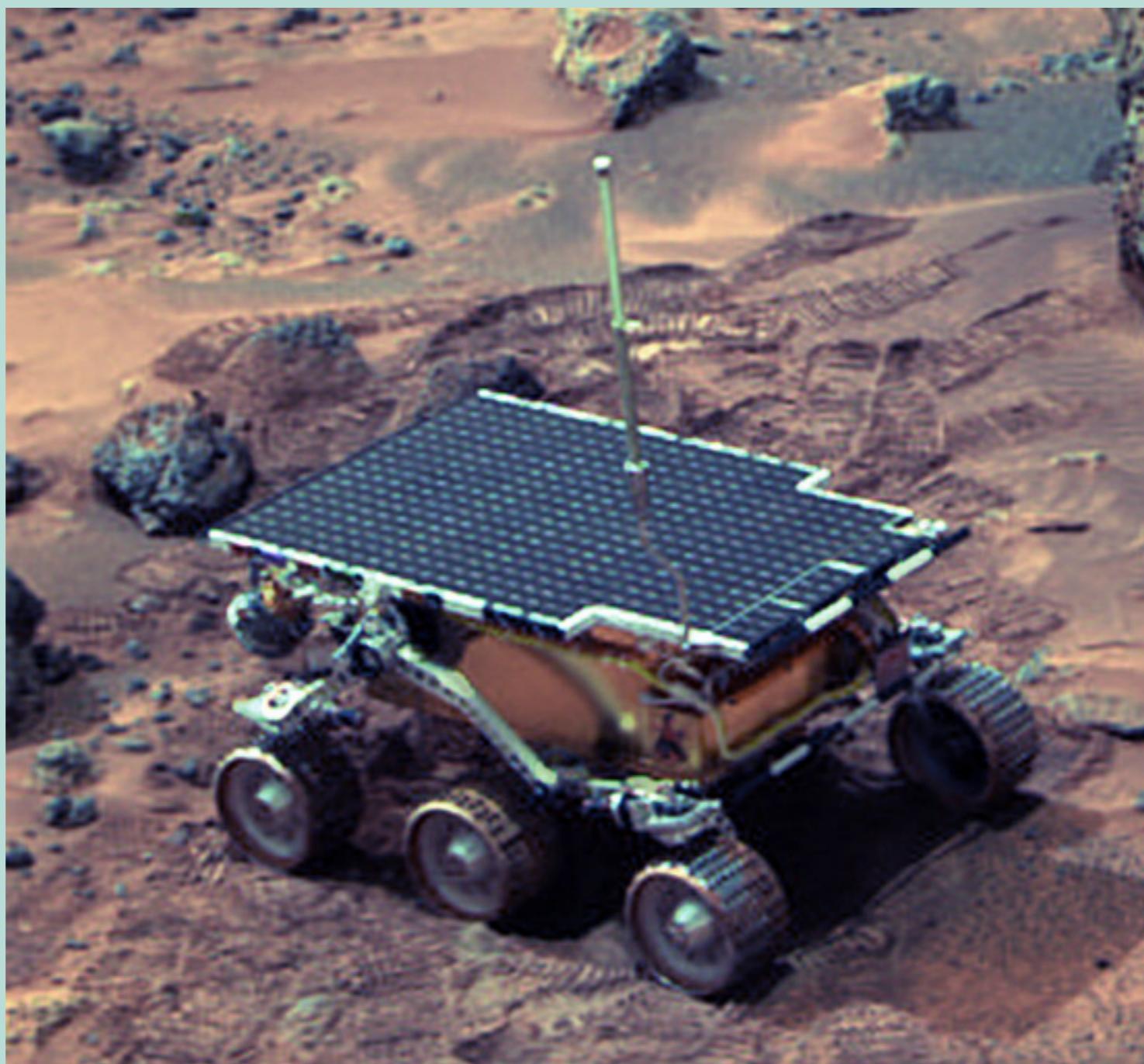
Mars: Ch 10



* Iron Oxide crust (rust)

Mars: Ch 10

Sojourner (1997)



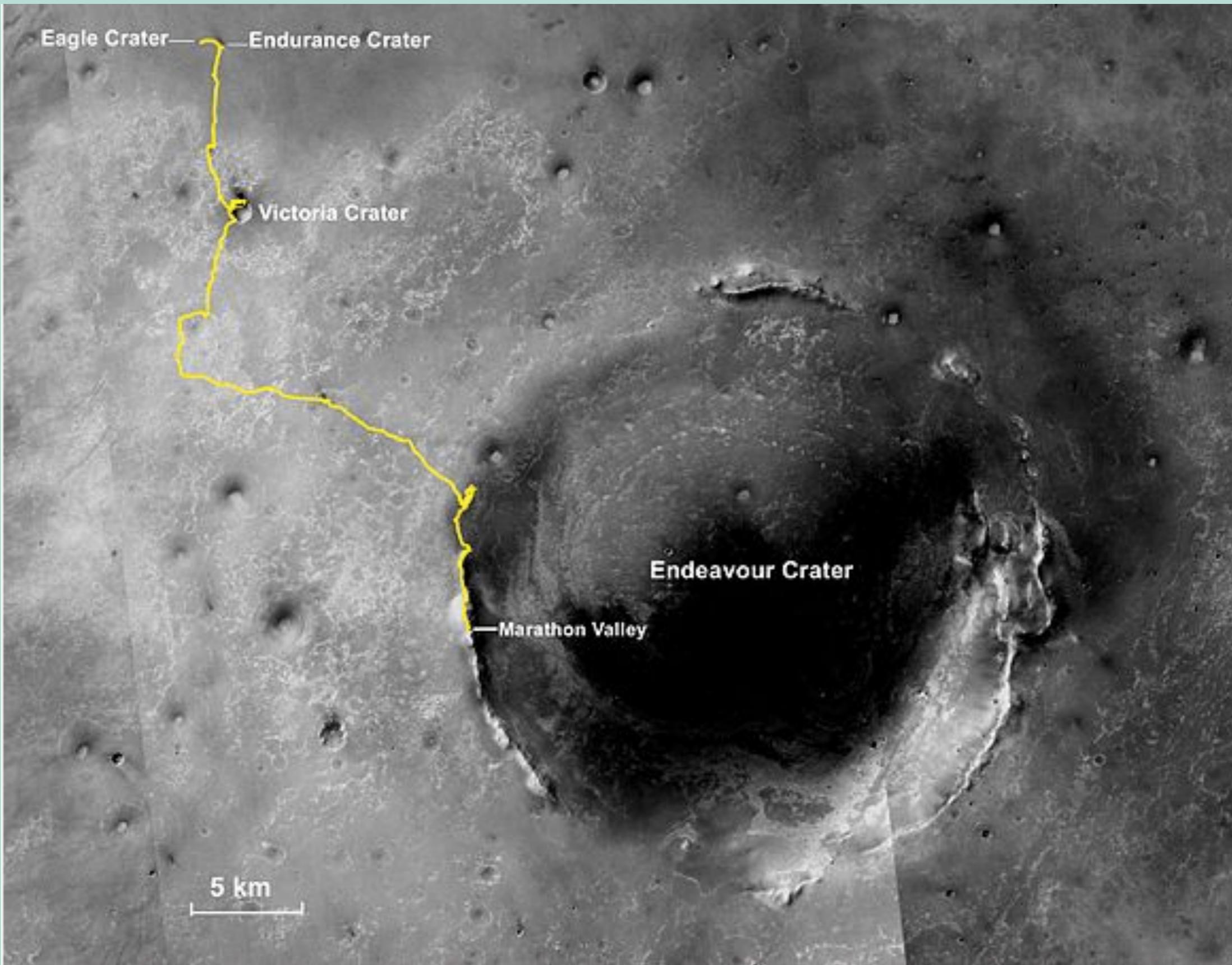
Mars: Ch 10

Opportunity (2004)



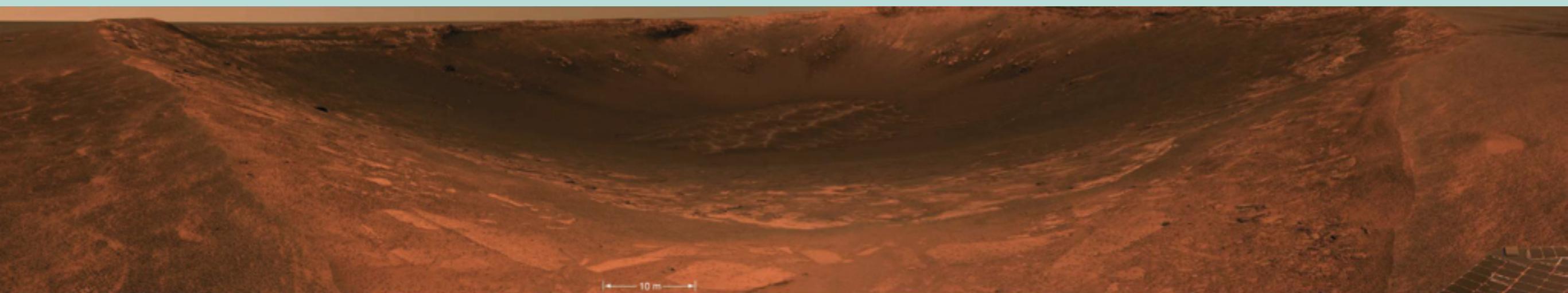
Mars: Ch 10

Opportunities Route



Mars: Ch 10

Panoramic View of Endurance Crater (Opportunity)



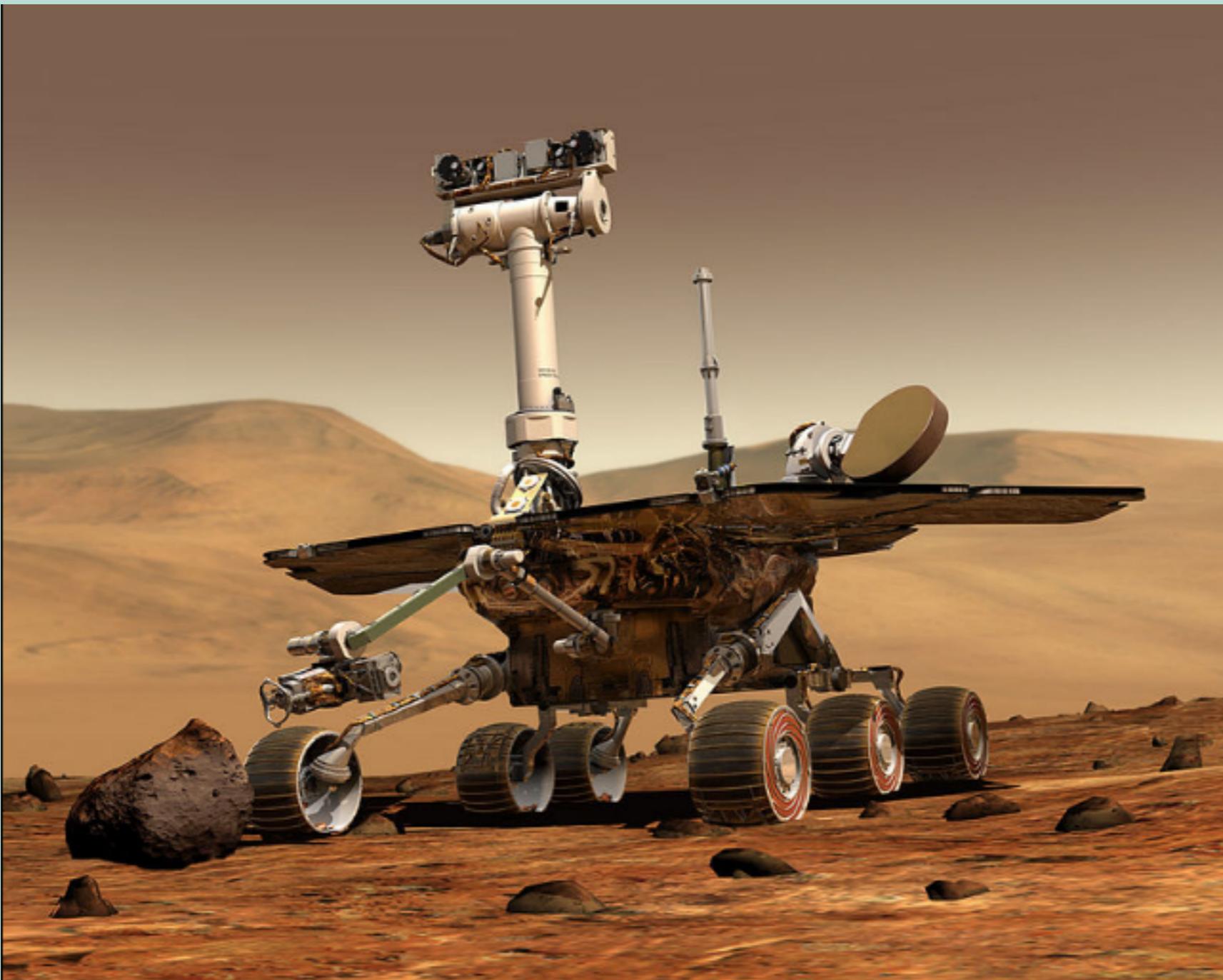
Mars: Ch 10



False Color Image (inside)

Mars: Ch 10

Spirit (2004)

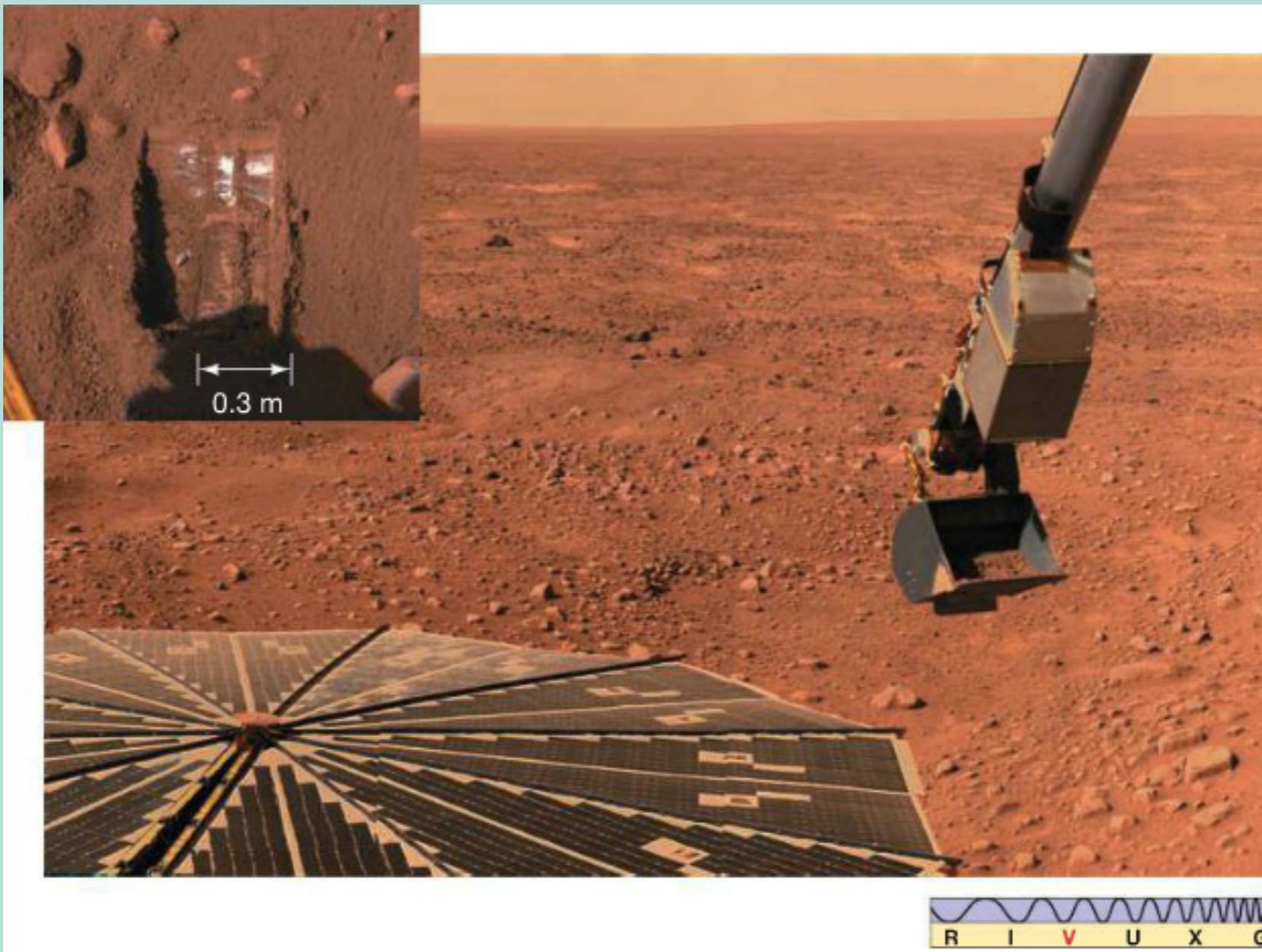


Mars: Ch 10

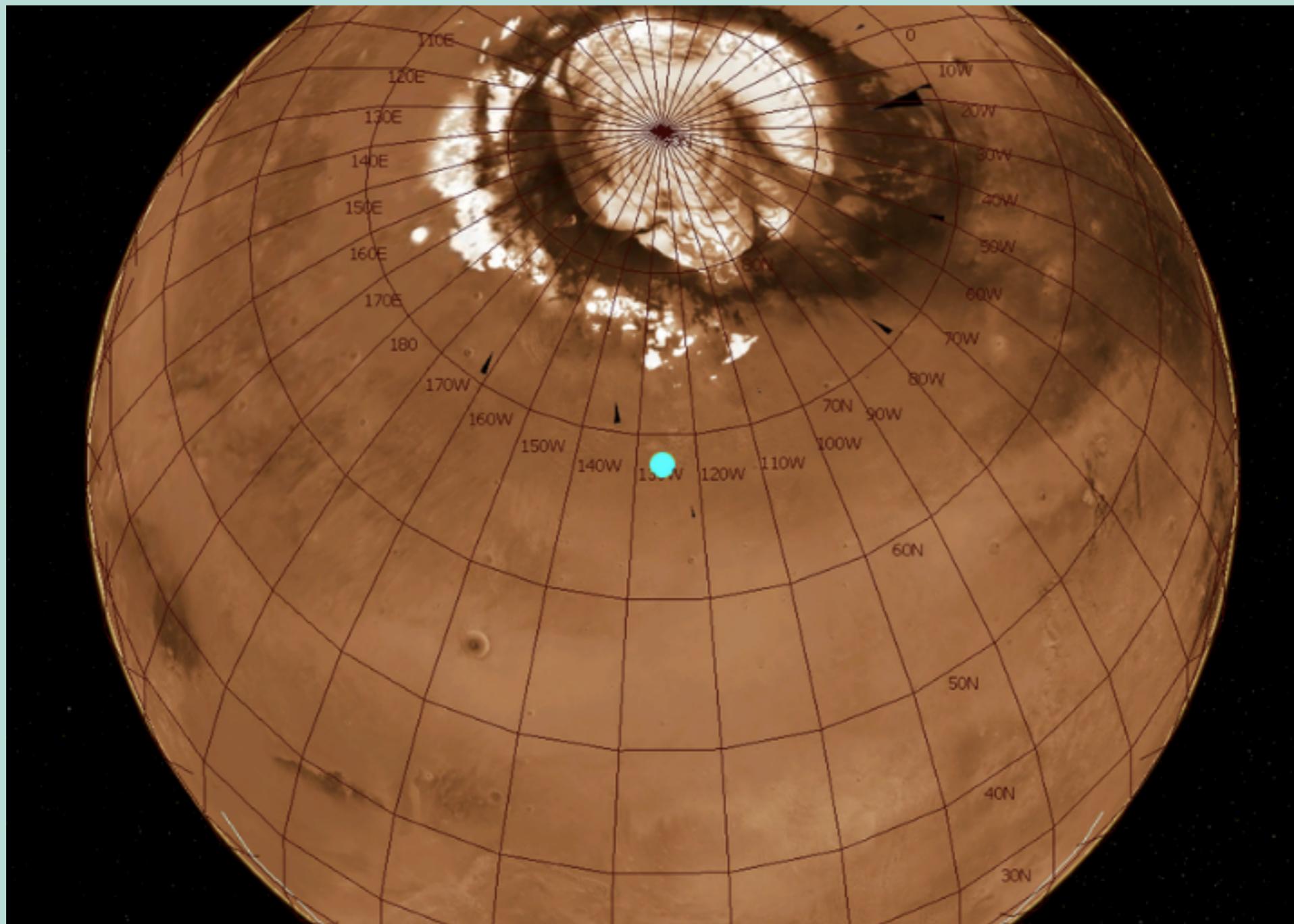
Phoenix (2008)



Subsurface Ice

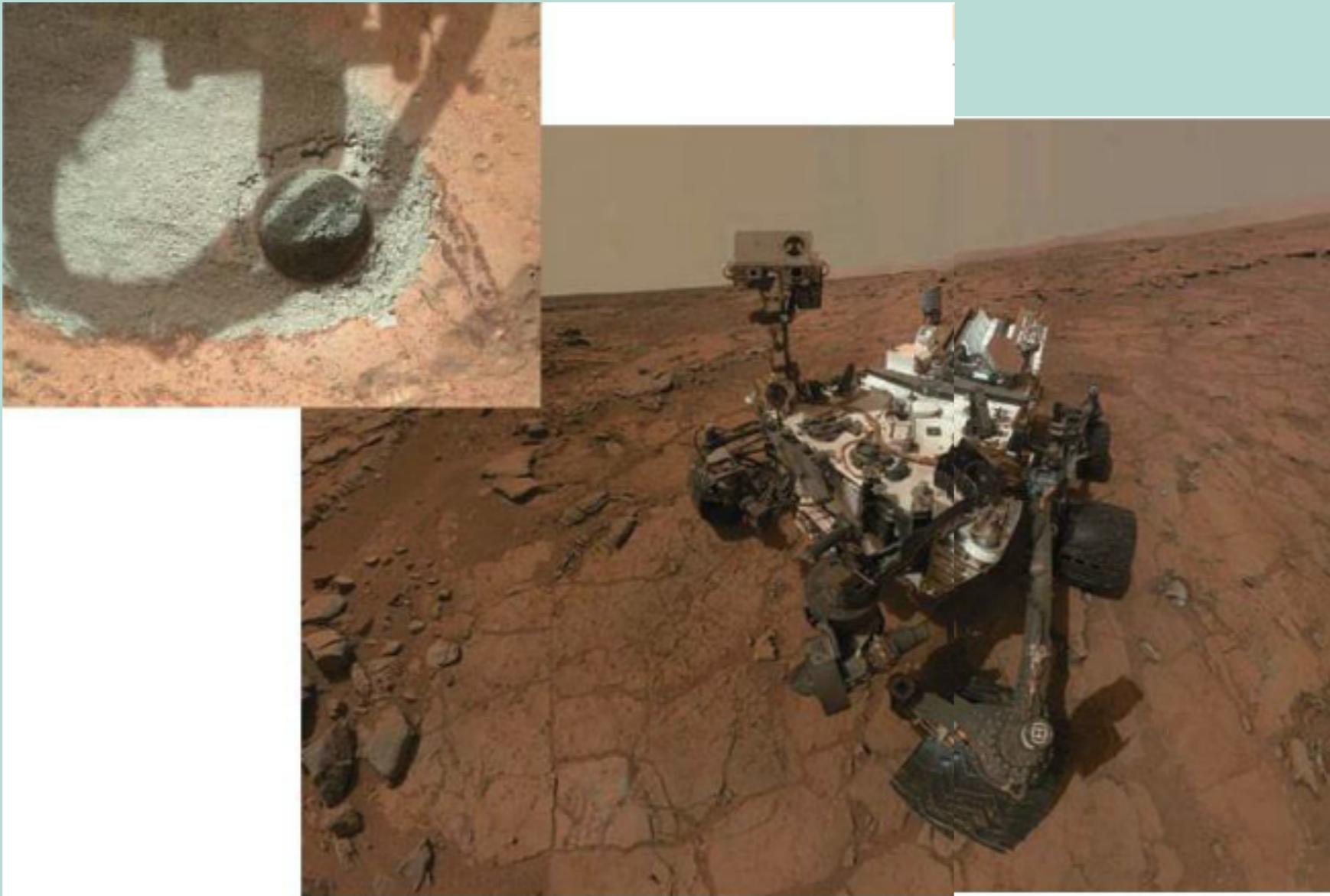


Phoenix Landing Site



Mars: Ch 10

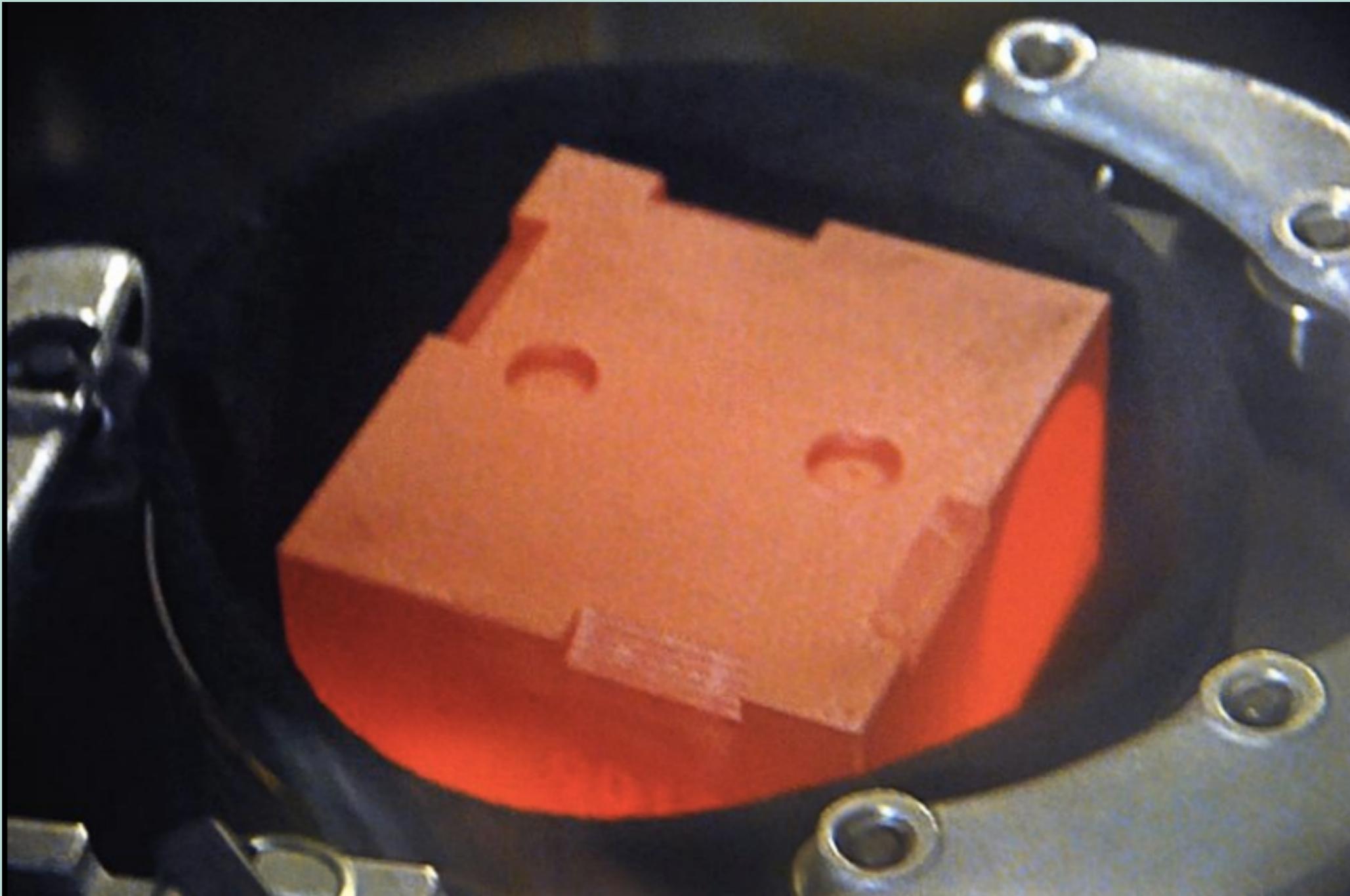
Curiosity (2012)





Mars: Ch 10

Curiosity's Iron Man Heart



Mars: Ch 10

Curiosity to Scale

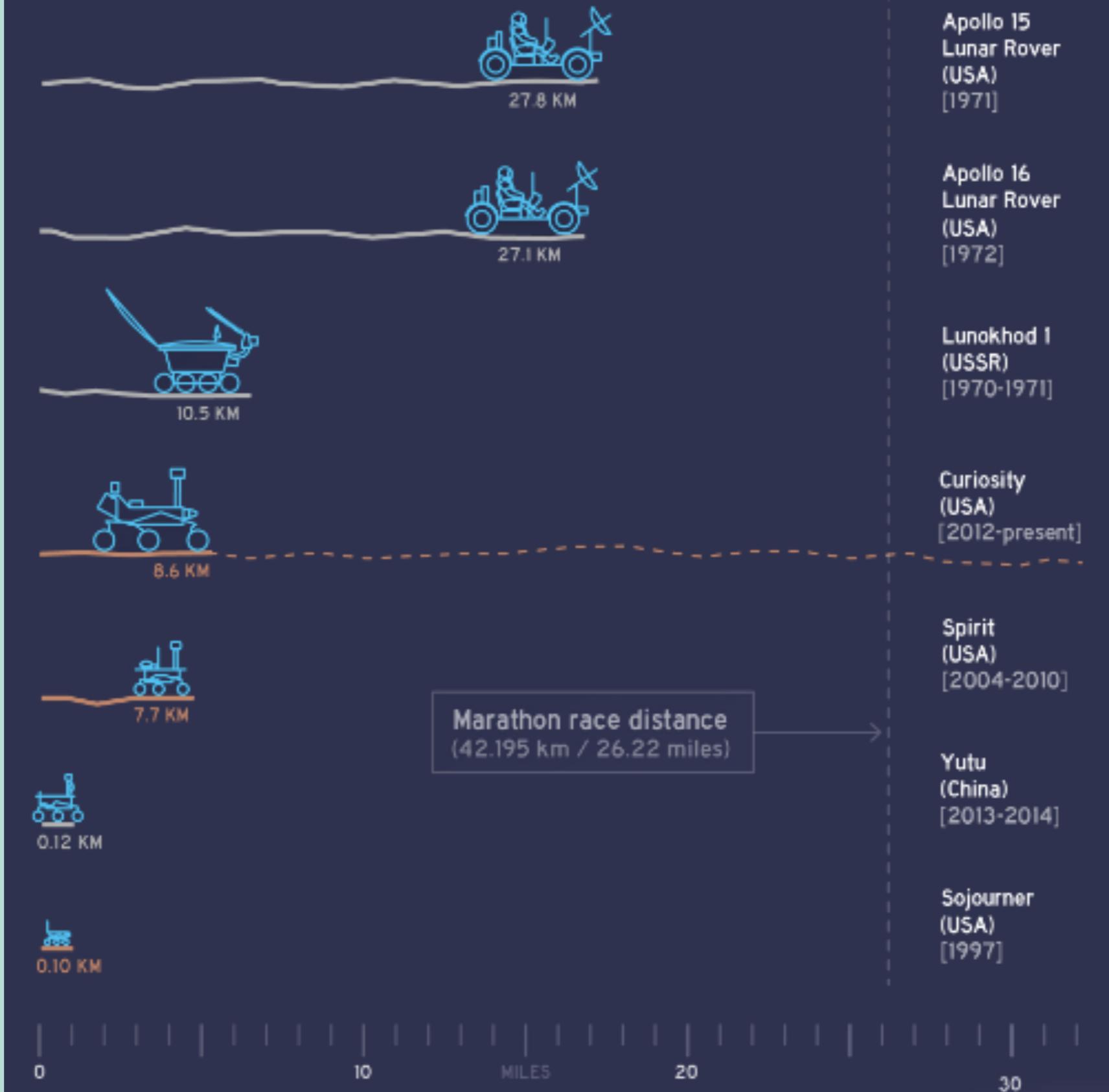


Mars: Ch 10

Curiosity
(September 2016)



Mars: Ch 10



FOR MORE INFO, VISIT
MARS.NASA.GOV

Mars: Ch 10



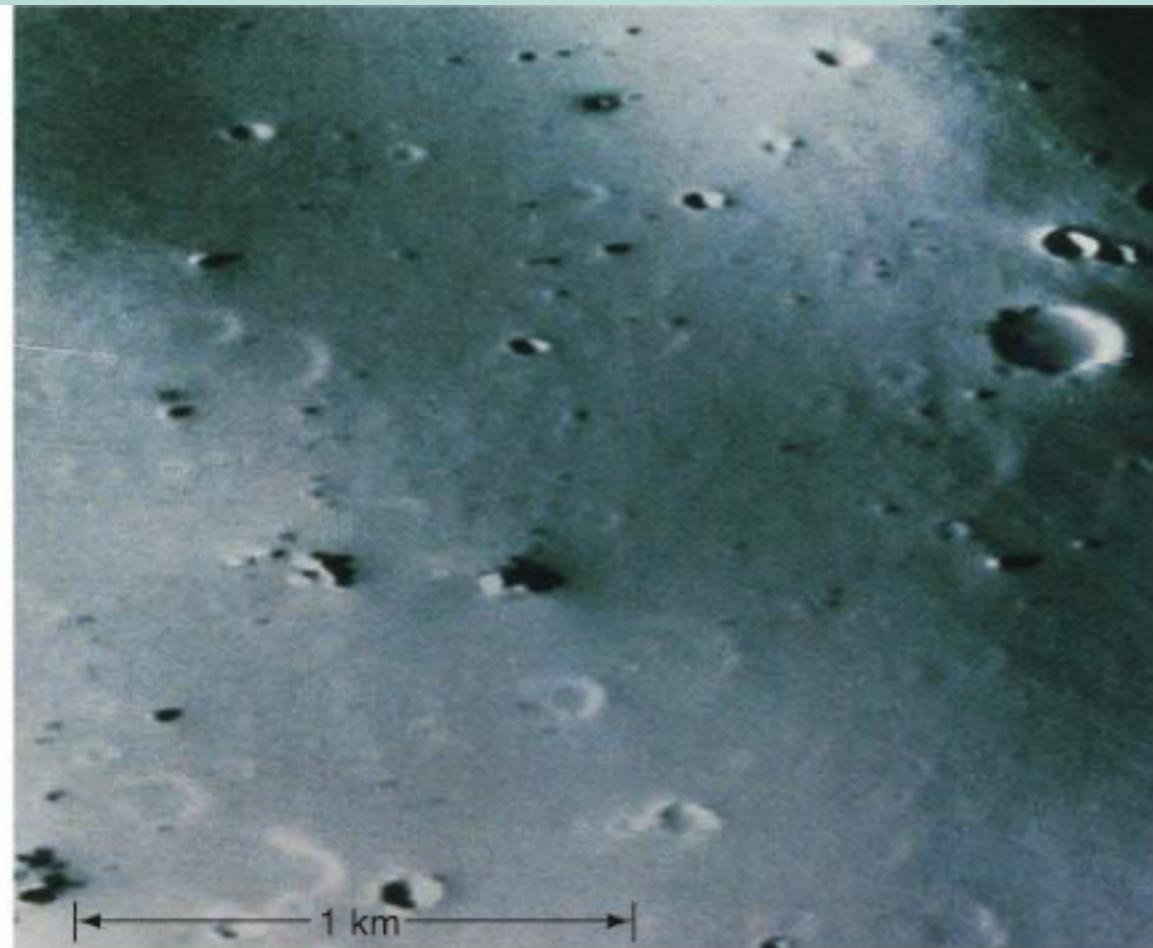
Courtesy of Curiosity

Mars: Ch 10

Phoebe and Deimos



(a)



(b)

