



## Basic information

Density (avg): 3.9 g/cm<sup>3</sup>

Distance from Sun (avg): 1.52 AU

Orbital Period: 687 Earth days

Rotation Period: 24 hrs, 36 min

Albedo: 0.25

Moons: 2

Atmosphere: *much* thinner than Earth's

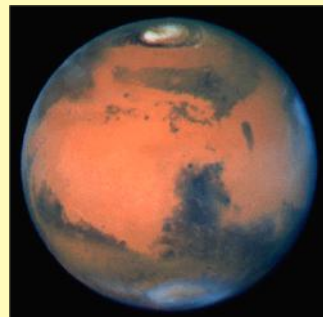
Tilt of rotational axis: 24°

## Mars "The Red Planet"

• named for *Roman god* of war

• *reddish* color from *iron-oxide* ("rust")

• *visible* surface features:  
*polar ice caps, volcanoes,*  
*changing dark regions*



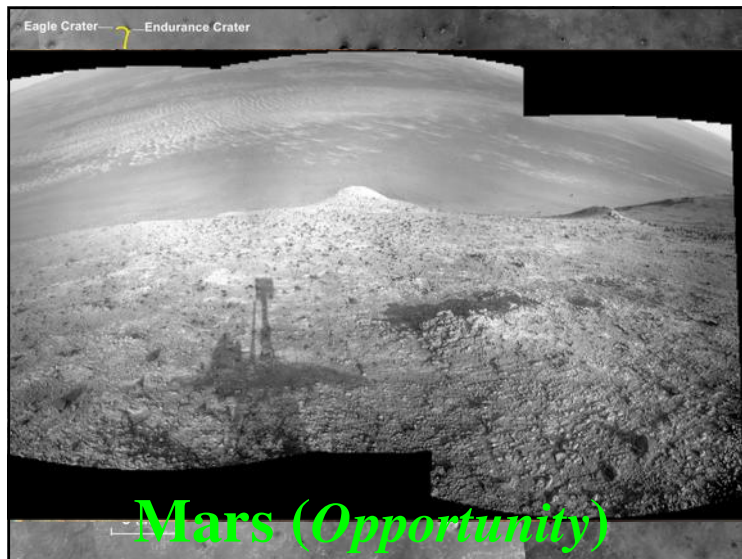
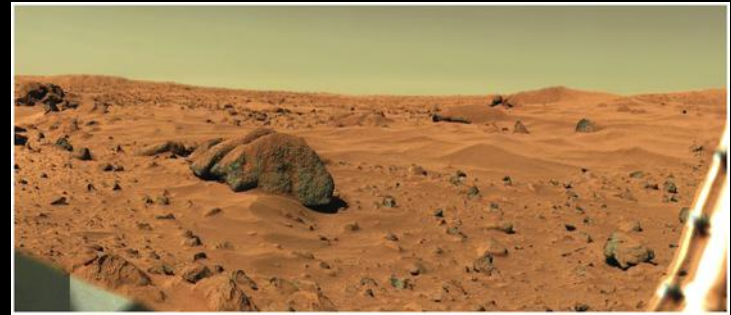
## Exploring Mars

- *Mars* (1960's-70's) – mostly failed USSR
- *Mariner 4&9* (1965, 1971) & *Viking* (1976) NASA
- *resolutions* from 1 km to 100 m (10 m)
- *Mars Global Surveyor* ; 2-10 m (1997) NASA
- *MER Spirit, Opportunity* (2003) NASA
- *Mars Express* (2 m in stereo) (2003) ESA
- *MRO* (0.25 m) (2006) NASA
- *MSL "Curiosity"* (2012) NASA
- *MOM, MAVEN* (2014) ISRO, NASA
- *TGO* (2016) ESA/USSR
- *InSight* (2018) NASA

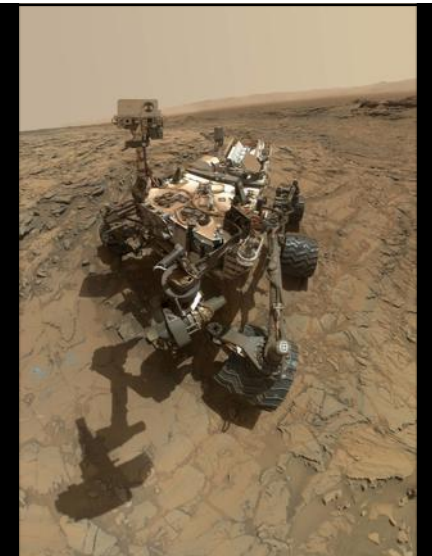
- **<50%** of ~60 Mars missions have *succeeded*



## Mars (Viking, 1976-82)

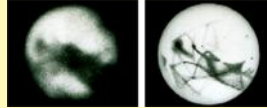


## Curiosity (2015)



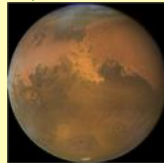
## Martian Canals

- *Huygens* sketched dark region *Syrtis Major* (1659)



- *Giovanni Schiaparelli* noticed a network of dark lines on surface, named them "*canali*" (*channels*)

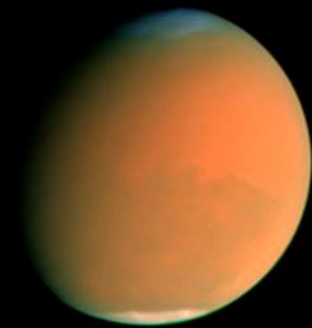
- *Percival Lowell*: "*Martian Canals*" (late 1800's)
- patterns of *light & dark material*
- *dust storms* blow *light "sands"* around, exposing *darker rock*



## Dust Storms



June 26, 2001



September 4, 2001

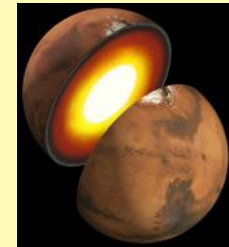
## Dustdevils at Gusev

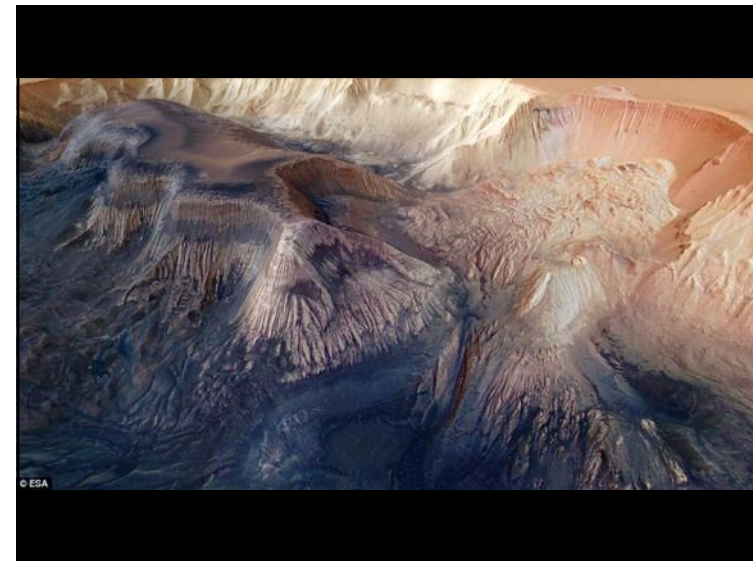
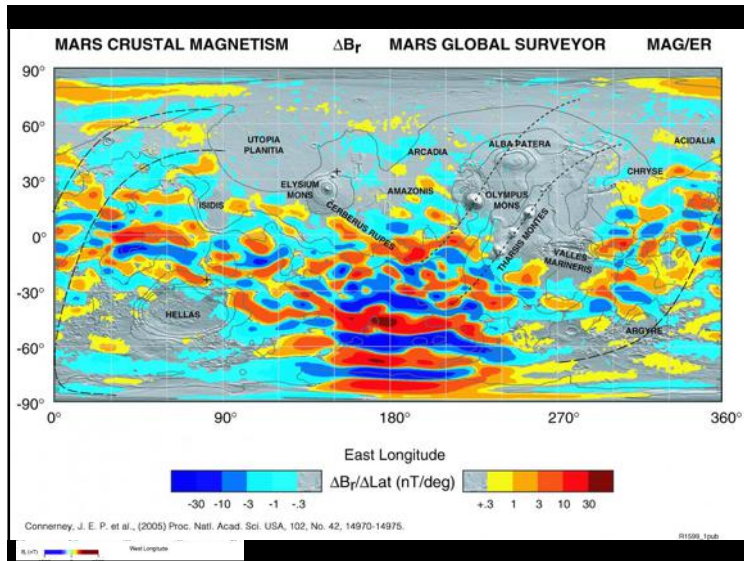


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## Interior Structure

- *little seismic data* (inSight!)
- *small size, lower density*  
– smaller core, "solid" interior?
- *remnant magnetic field*
- *past evidence of plate tectonics?*
- *Valles Marineris*:  
*largest & deepest*  
canyon system in solar system could be a *plate boundary*





## Volcanoes

- *extinct* volcanoes: *mantle hotspots*?

- *two main regions (N. Hemisphere): Tharsis Region & Elysium Planitia*
- *little* cratering near many volcanoes - *why*?

- **Olympus Mons**: largest volcano in the solar system (27 km high or 3x height of Mt. Everest)

**Q:** Why is it so large? (would cover 1/4 of BC!)

- *low gravity*, **no active plate tectonics**

## Atmosphere

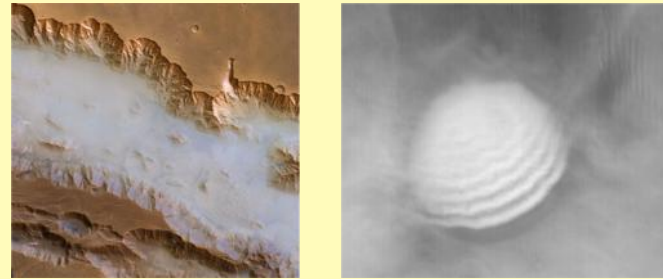
- pressure: 0.007 bars (<1% of Earth)

	Venus	Earth	Mars
Nitrogen (N <sub>2</sub> )	3.5%	78.08%	2.7%
Oxygen (O <sub>2</sub> )	almost zero	20.95%	almost zero
Carbon dioxide (CO <sub>2</sub> )	96.5%	0.035%	95.3%
Water vapor (H <sub>2</sub> O)	0.003%	about 1%	0.03%
Other gases	almost zero	almost zero	2%

- trace O, CH<sub>4</sub>
- source: volcanic... (biologic??)
- atmosphere *escaped into space* (low gravity)

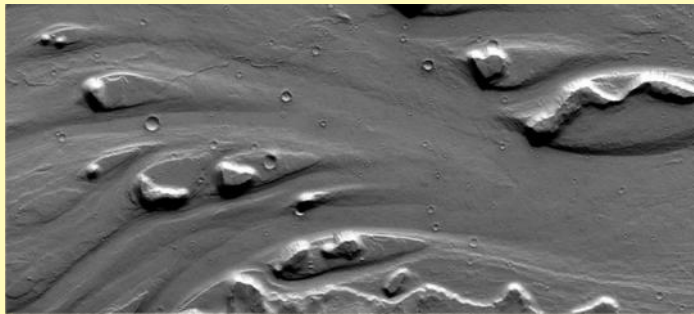
## Temperature

- “Daytime” temperature: 240 K (-33°C)
- “Nighttime” temperature: 170 K (-103°C)
- *ground* temperature can *exceed 0°C*



## Water on Mars

- *liquid water on the surface* would **boil/freeze**
- but... *evidence* for liquid water *in past*; present?

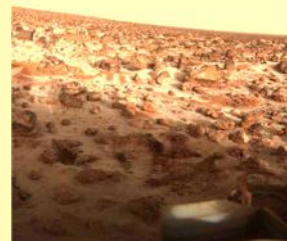


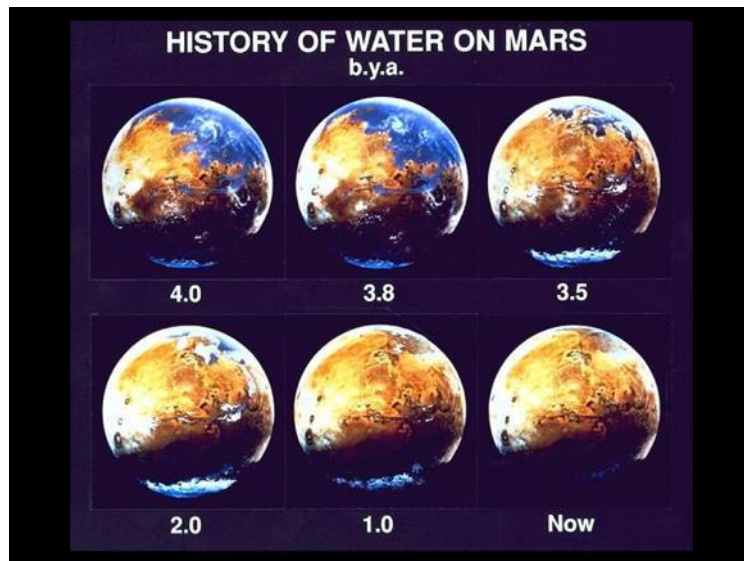
- *visual evidence*
- *chemical evidence* from rovers (*hematite, sulfates*)
- *salty, shallow seas* (?) covered *northern lowlands*

- *volcanic activity*
- *greenhouse effect*  
⇒ *thicker, warmer atmosphere*

*Q: Where is the water now?*

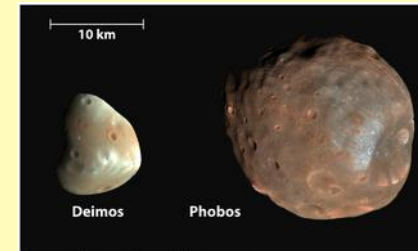
- *vaporized, ice caps, subsurface* (*permafrost*)





## Moons of Mars

- **Phobos** and **Deimos** (discovered by A. Hall, 1877)

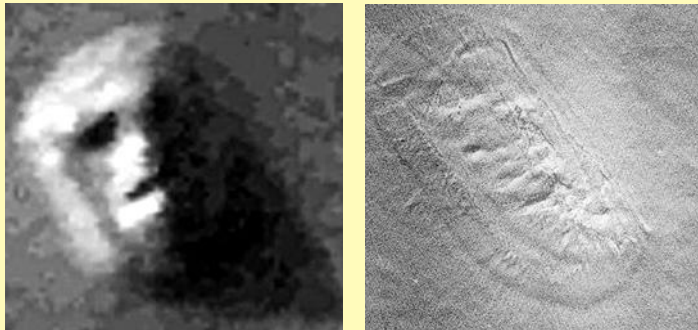


- "**Fear**" & "**Panic**", chariot horses of **Mars**
- 6000 km & 20,000 km from **Mars**

*Q: What are their (likely) origins?*

## "Face" on Mars

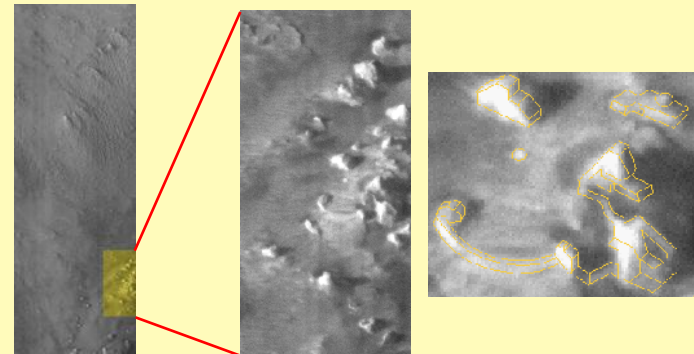
- just a trick of lighting



*Q: Why is quality on left so bad?*

## Martian "Cities"

*Cydonia (Candor City)*





**CLICKER:**  
*Evidence that Mars once possessed significant water on its surface is ...?*

- (a) minerals found in rocks examined by rovers*
- (b) significant water ice found in Mars' ice caps*
- (c) ancient flow patterns on the surface*
- (d) all of the above*