Astronomy 330:

Extraterrestrial Life

This class (Lecture 12):

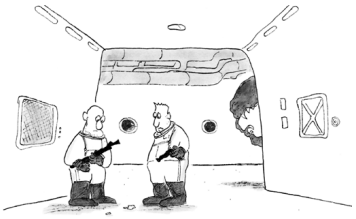
Life in the Solar System

Stephanie Gerstetter

John Ryan

Next Class:

Life in the Solar System



Alien boogers

HW #5 due Sunday night.
No Class March 19th

Music: *Venus as a Boy*— Bjork

HW #2

Akshay Murthy
http://www.ufosonearth.com/site/cia-agent-claims-to-have-seen-direct-evidence-of-alien-visitation/
Roswell incident— now, and only now, a CIA agent, Chase Brandon, has come out and said that it "was a craft that did not come from this planet"

Tyler Blum
http://www.dailymail.co.uk/sciencetech/article-2843871/Ancient-Martian-civilisation-wiped-nuclear-bomb-wielding-aliens-attack-Earth-claims-physicist.html
John Brandenburg presents his theory that there was a nuclear war on the face of Mars based on Xenon

2

Earth-Mercury Comparison

Mercury is the closest planet to the Sun. Mercury has the most elliptical orbit of any planet and orbits in a 3:2 spin resonance.

Radius	0.38 Earth
Surface gravity	0.38 Earth
Mass	0.06 Earth
Distance from Sun	0.39 AU
Average Temp	167 C (> 600 C Sunward)
Year	87.97 Earth days
Length of Day	**58.6 Earth days**
Atmosphere	Vacuum

http://nssdc.gsfc.nasa.gov/planetary/factsheet/mercuryfact.html

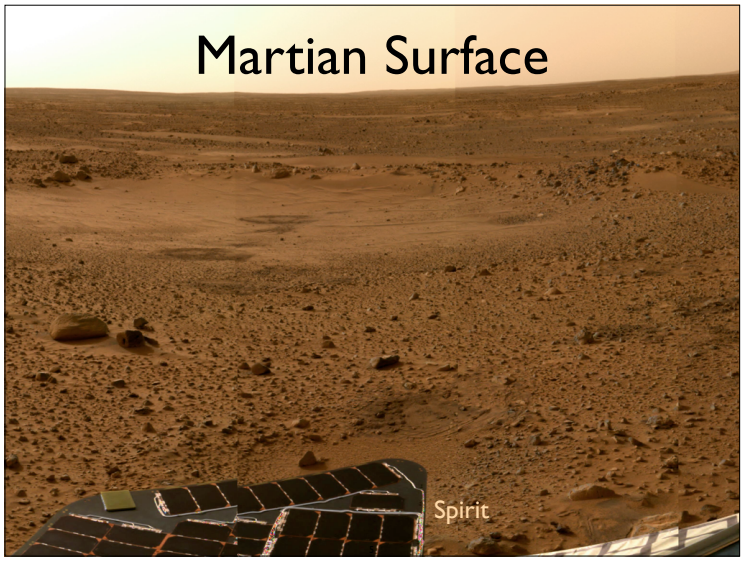
Drake Equation

Frank Drake

That's 24 planetary systems/year

$$N = R_* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

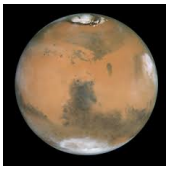
# of advanced civilizations we can contact in our Galaxy today	Star formation rate	Fraction of stars with planets	# of Earthlike planets per system	Fraction on which life arises	Fraction that evolve intelligence	Fraction that communicate	Lifetime of advanced civilizations
	30 stars/yr	0.8 systems/star	planets/system	life/planet	intel./life	comm./intel.	yrs/comm.

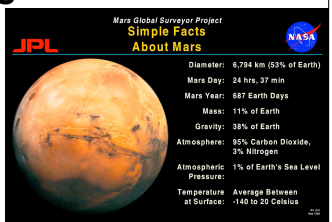


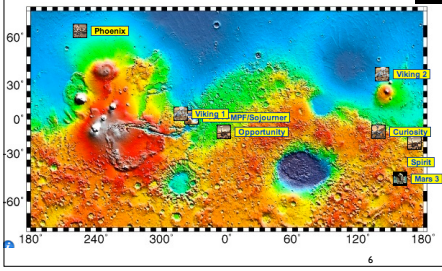
http://osoncje.tripod.com/planeti/04Mars/mars_spiritcolor_PIA05015_c1.jpg

---

Mars







Mars is tilted at 25.2°

1 Solar day on Mars (1 sol)

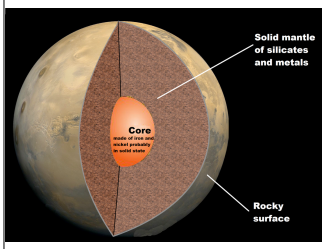
24 H: 39 M: 35 S

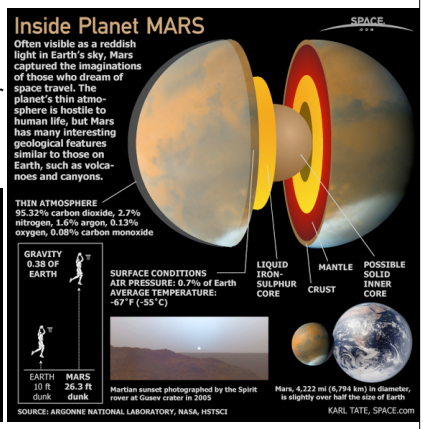
Martian Interior

Mars has an Iron core
(Half of the Planet's radius)

Heavily contaminated with Sulfur

Weak magnetic field: thin outer liquid Iron layer?





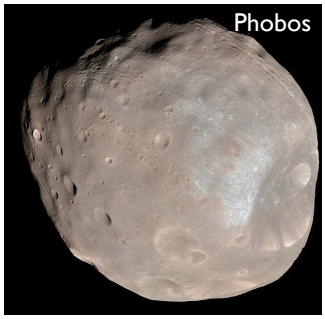
7

http://2.bp.blogspot.com/-8I_XDOKXt3w/TkrtHxpOXXI/AAAAAAAAApM/c9qLDsuKKGY/s1600/marsstructure.png

Martian Satellites

Captured Asteroids?

15-25 km across: potato shaped.



8

Phobos, only orbiting 6,000 km (3,700 mi), is getting closer to Mars by one meter every century, predicted that in 50 million years it will collide with the planet or break up into a planetary ring

Question

Mars has more what than the other three terrestrial planets combined?

a) Water Ice

b) Iron Sulfides

c) Aliens

d) Moons

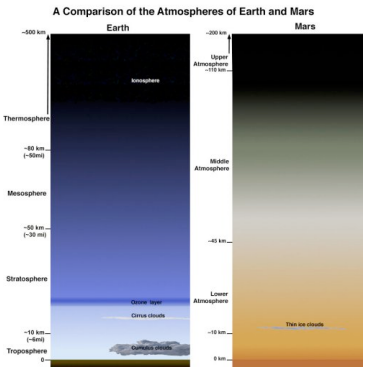
e) Combat victories

iClicker

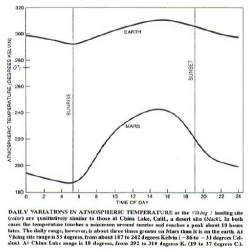
9

C

Martian Atmosphere



Large daily temperature swings



DAILY VARIATIONS IN ATMOSPHERIC TEMPERATURE at the Viking / landing site (color) are qualitatively similar to those at Chino Lake, Calif., a desert site (black). In both cases the temperature reaches a minimum several months and reaches a peak about 10 hours later. The daily range, however, is about three times greater on Mars than it is on the earth. At Viking site ranges is 55 degrees, from about 187 to 242 degrees Kelvin (−86 to −31 degrees Celsius). At Chino Lake range is 18 degrees, from 292 to 310 degrees K. (19 to 37 degrees C).

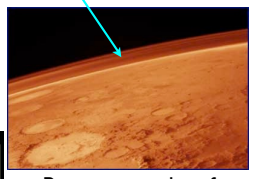
Surface Pressure: 40 km in Earth's Atmosphere

Large daily and seasonal swings in surface temperature

Martian Atmosphere

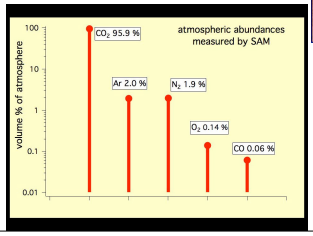
Interplay between Polar Caps & Atmosphere

Atmosphere: 1% Earth



Pressure too low for Liquid Water

Atmosphere too thin for Greenhouse Effect



http://hubblesite.org/newscenter/archive/releases/solar-system/mars/1999/27/video/a/

95% carbon dioxide. Atmospheric pressure 0.6% of Earth's – like 40 km altitude on Earth. Too thin for significant greenhouse effect. Pressure is too low for liquid water. Not protected by a global magnetosphere like Earth's

Mars might have had an oxygen rich atmosphere billions of years ago

---

Martian Surface

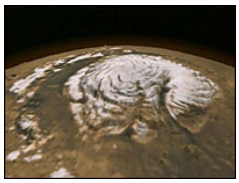
Iron Oxide: Fe_2O_3

Desert

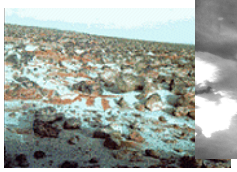
Mars is a desert! Iron oxide in soil gives reddish cast.

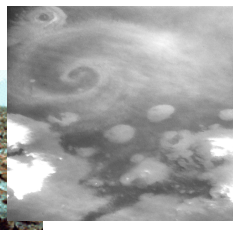
Water on Mars

There **is** water on Mars
- North and south polar caps (but mostly CO_2)
- Some water vapor in the air
- Frost on rocks
- Clouds (ice crystals)



No *liquid* water now

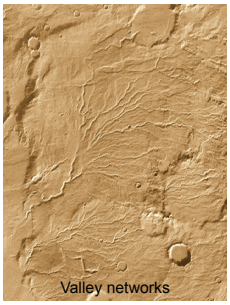


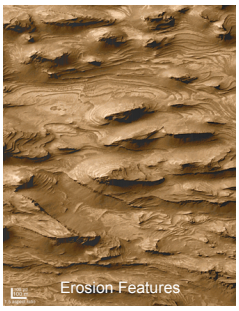


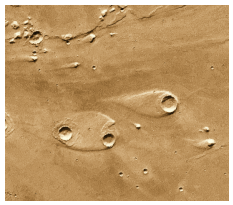
Liquid water on Mars?

Water erosion features visible from space

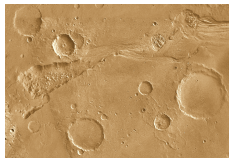
Today atmospheric pressure too low for liquid water to exist





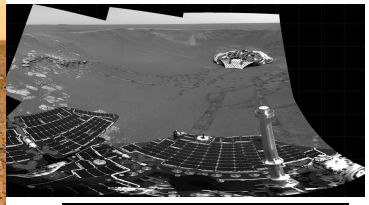


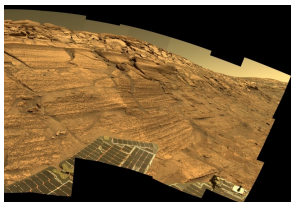
"Islands"



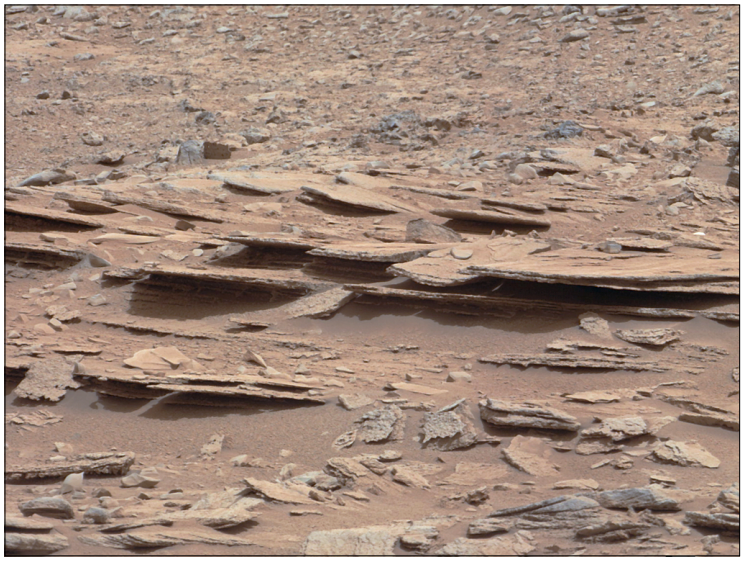
Flood erosion

Roving on Mars



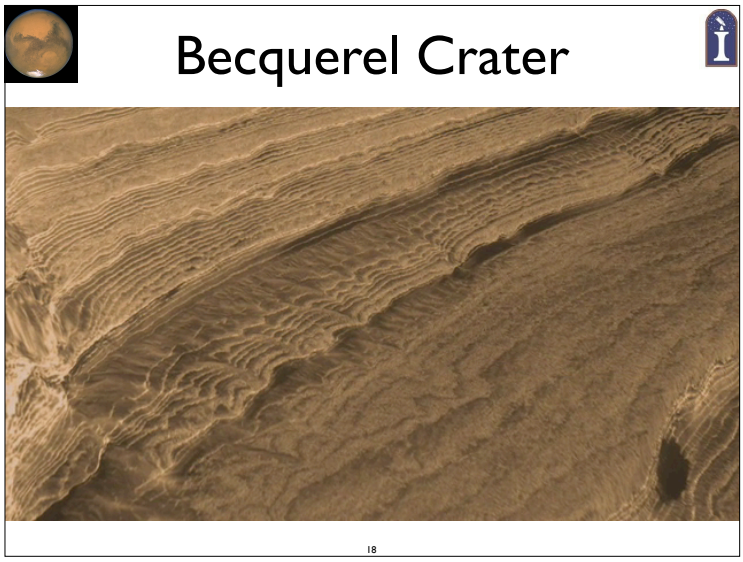


http://antwrp.gsfc.nasa.gov/apod/image/0403/emptynest_opportunity_big.jpg

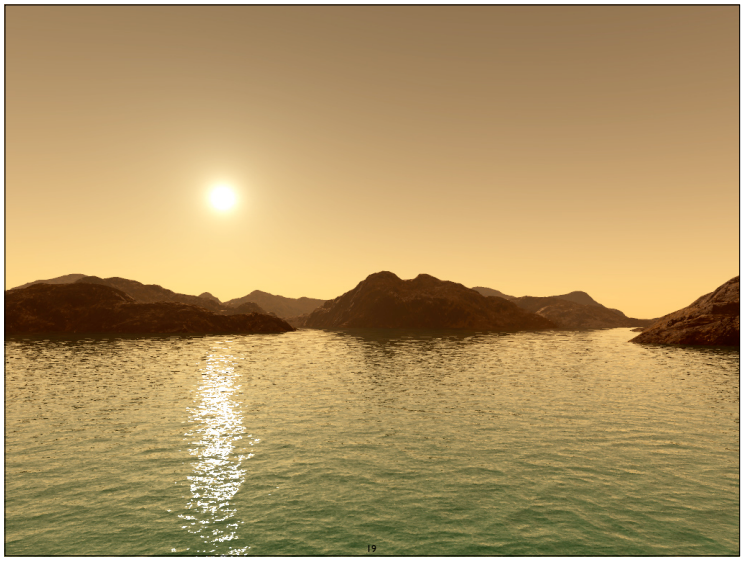


http://www.jpl.nasa.gov/images/msl/20121211/pia16550-43.jpg

http://www.jpl.nasa.gov/images/msl/20121126/pia16453-43.jpg



Layered sedimentary rocks!

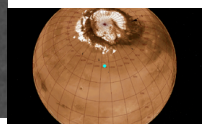


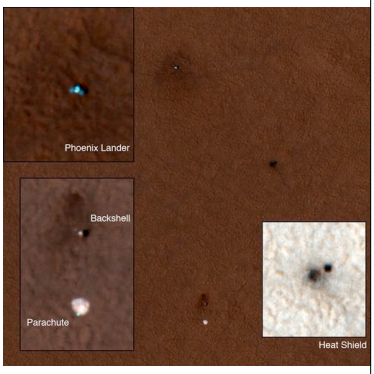
19

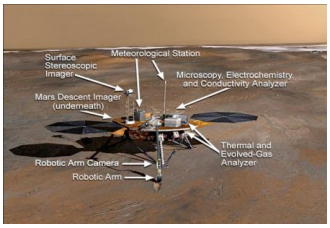
http://www.ig.utexas.edu/research/projects/mars/education/pictures/others/mars_pond_day.jpg

Phoenix at the Poles

Phoenix: Analyze Water at North Pole







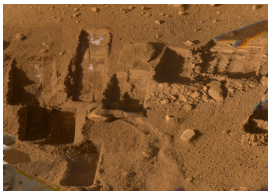
20

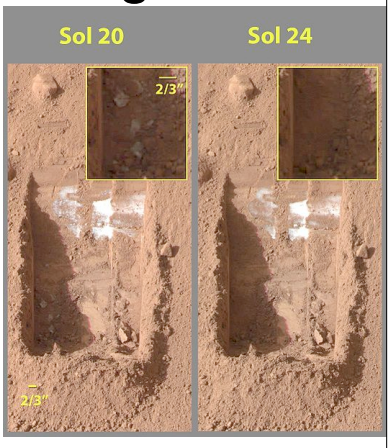
Phoenix Digs

Phoenix:

Confirmed surface water ice

CO_2 would sublimate more quickly



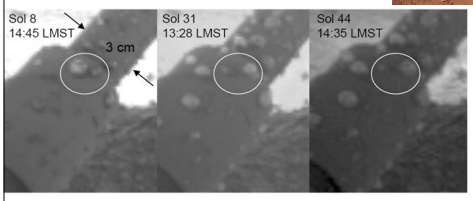


21

Phoenix Water Drops

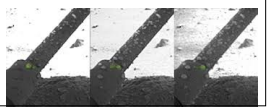
Phoenix:

- Blob merge (Between 8 & 31)
- Liquid (Saltwater?)
- Splashed up during landing?



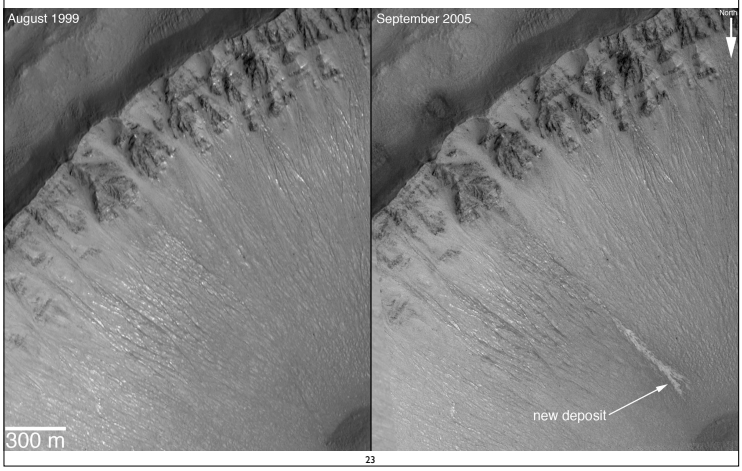
Hypothesis:
Perchlorate Salts

Still Controversial



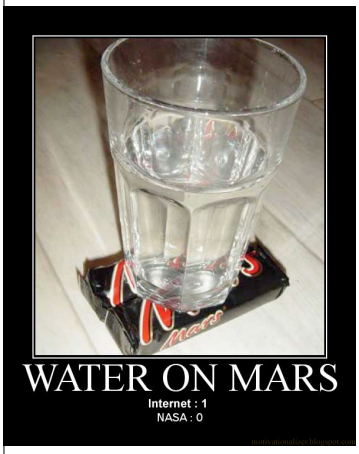
22

Underground Water?



23

What Happened?



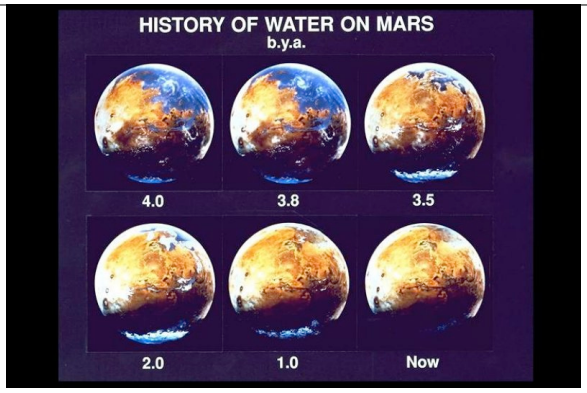
The **BIG** question!

Evidence exists for water both now and in the past

Did surface water escape into space with atmosphere?

How much water is frozen beneath the surface?

24



Early Mars: Geologically active
Volcanic eruptions lead to CO_2 + N atmosphere.
Greenhouse effect warmed planet to allow liquid water
Oceans, Rivers? Polar Glaciers, *Life*?

25

What Happened?

Mars was too small

- Insufficient internal heat
- Plate tectonics stopped
- Shield volcanoes parked over hotspots, grew large
- Atmosphere escaped
- Planet Froze
- Life?

26

Question

Which of the following is not likely to have happened during the past on Mars?

a) Water on surface

b) Growth of large shield volcanoes

c) Greenhouse effect

d) Bulk of atmosphere escaped into space

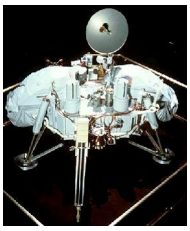
e) Human colonization

iClicker

27

E

Martian Life



Viking 1 & 2: Life Experiments

Four Biological Experiments

Labeled Release: Positive Result

Other experiments negative

Inconclusive!

Reanalysis suggests Viking did find Organics.

Perchlorate Salts in soil would destroy

Subsequent Math test: Signal was real.

Controversial Still!

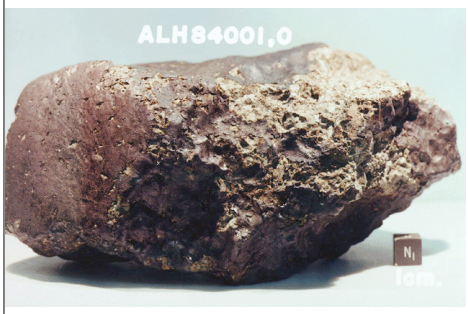
28

Orbiter mission operational from the 70's until the 80's. Landers operational for about 6 years.

Perchlorate will destroy any organics when heated— producing chloromethane and dichloromethane, which were detected by both Viking landers

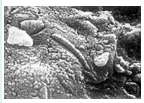
Martian Life

Martian Meteorite: Discovered in Antarctica



Found in August 1996

3 Gyrs old



Microscopic Shapes

Fossil nanobacteria?

versus

Organic chemical compounds?

14 known Martian meteorites known.

29

Microscopic shapes that resemble living and fossil bacteria on Earth- nanobacteria, but much smaller than on Earth.
Microscopic mineral grains like some produced by living and fossil bacteria on Earth
Organic chemical compounds that resemble the decay products of bacteria on Earth.
In the end, not compelling enough. Non-biological processes can probably produce the observed features