SDSU Astr 310 Astrobiology **Prof. W. Welsh**

MARS

Mars has a transparent atmosphere with occasional clouds and dust storms (weather).

Temperatures: highs: 20^{o} C (max at noon in summer); 90^{o} C (same spot at night);
lows: about -125 C

Mars has a large orbital eccentricity (ellipticity of the orbit; for Mars $e = 0.093$; for Earth's $e = 0.017$). On Earth, the difference between aphelion and perihelion (furthest and closest approach to the Sun) is ~ 3% (the orbit is nearly a circle). But on Mars, the eccentricity is ~19% ! Due to the large orbital eccentricity, the seasons are: *moderated* in the North *enhanced* in the South. This leads to strong winds and huge dust storms.

Although Mars resembles Earth in some ways, it is quite different.
In particular, the atmosphere is very different: **Atmosphere is 95% CO_2**
But more importantly, **Mars has a <u>much thinner atmosphere</u> than Earth.**
Surface pressure is only about 0.7% of the Earth's.

Observing Mars *from Mars*

Although we can learn a lot from Earth, the best way to study a planet is to go there. Mars is the best studied planet in the Solar System. Many spacecraft have been sent to Mars. In particular, four missions stand out above the rest:

- Orbiters: *Mariner 9* and *Mars Global Surveyor (*new: *Mars Reconnaissance Orbiter)*
- Landers: *Viking, Mars Exploration Rovers*

Some Key Missions to Mars:

- Mariner 4 (1965): flyby
- Mariner 9 (1971): orbiter
- Viking 1 & 2 (1976): 2 orbiters & 2 landers
- Pathfinder+Sojourner (1996): lander & rover
- Mars Global Surveyor (1996 – still active): orbiter
- 2001 Mars Odyssey (still active): orbiter

Missions in progress:

- MER: Mars Explorer Rovers (*Spirit* and *Opportunity*) (NASA)
- Mars Express (ESA)

Large Surface Features on Mars

Mars has two distinct topographical regions.

1) Relatively smooth plains, northern hemisphere:
Young (< 500 million years); below average elevation

2) Heavily cratered highlands, mostly southern hemisphere:
Old (>3.8 billion years); above average elevation (1-4 km)

The reason for this dichotomy is unknown: Possibly due to a huge impact early in the formation of Mars?

Olympus Mons: enormous volcano; largest in the solar system; implies little plate tectonic motion; few craters, therefore a moderately young surface. Size: 600 km across and 25 km high! (82,000 ft); probably extinct for 1 billion years. Olympus Mons is much larger than any volcano on Earth. Similar features on Earth would sink into the crust!

Valles Marineris: "Valley of the Mariners" is a *huge* series of canyons over 4000 km long, up to 600 km wide and 7 km deep!

The Surface Composition of Mars

Surface composition: About 50% silicon dioxide (sand) and about 13% iron oxide (rust); essentially an iron-rich clay.
Viking showed that the soil *(regolith)* <u>*contains no organic compounds*</u> – none!
This is because the regolith contains highly oxidizing compounds (peroxides) that destroy any organic molecules. With peroxides and unshielded UV radiation from the Sun, the surface of Mars is a very hostile place for life!

<u>*Evidence of Past Water on Mars*</u>

-Visual similarity to waterways on Earth
- Dried "river" features and flood plains
- Smooth-rimmed craters
- Muddy-looking ejecta around craters
- Gullies on some crater walls

There may have been large bodies of water on Mars in the past. We don't know for certain. Could the smooth plains of the northern hemisphere have been caused by an ancient ocean??
We do know this for certain: **There is no liquid water on Mars today.** The atmospheric pressure is much too low. In fact, there have been no <u>large</u> bodies of liquid water on the surface of Mars for billions of years.

<u>*Why all the fuss about liquid water on Mars?*</u>

<u>Liquid</u> water is one of the 3 key ingredients necessary for life (as we know it):

- A source of energy (e.g. Sunlight, thermal, chemical)

- Organic material

- Liquid water

Note: these are ***necessary,*** but ***not sufficient.***
Another important condition is **long-term stability**: the environment had to be just right for a long time. This is especially true for the origin of multicellular life (plants, animals).

For the terrestrial planets, the Sun and internal heat (radioactivity) provide energy. Organic material is generally available, either homemade, or from comets and meteors.
<u>***So the key is to find liquid water.***</u> There is no liquid water on Mars today, but in the past, there may have been a lot. *Could life have once flourished on Mars??*