Mars in History
Mars in History

Mars is Peopled

and they want

Kirk's American Family Soap

Kirk's Dusky Diamond Soap, best for Ladies Toilet.

Mr. Yerkes
$500,000 Telescope

Mr. Yerkes Cable to Mars
Thus began the fascination with the idea that Mars contained life.
Mars

- Mass (1/10), radius (1/2) and atmosphere (.7–.9%) smaller than Earth’s.
- Rotation rate is nearly that of Earth’s.
- Reddish color due to iron oxide.
- Noachian epoch: before 3.5 Gyr; oldest surface features (Tharsis bulge) and late, extensive water flooding
- Hesperian epoch: between 1.8 and 3.5 Gyr; formation of extensive lava plains
- Amazonian epoch; after 1.8 Gyr; formation of Olympus Mons and other lava flows
Mars Geology

- Has craters and high volcanos (higher than on Earth due to lower gravity).
- No active volcanos or geologic activity for last 1–2 Byrs, due to low mass and therefore less radioactivity.
- Valles Marineres is a large canyon (7 km deep, 100 km wide, stretches 1/4 across planet), formed by cracking of crust as Mars cooled.
Mars Topography
Mars Atmosphere

- Polar caps (H₂O mostly, with surface CO₂) which grow and shrink according to the seasons.
- Atmosphere only 0.7% of Earth’s, below the triple point of water, so no liquid water possible at any temperature.
- 95.7% CO₂, 2.7% N₂, 1.6% Ar, 0.2% O₂, 0.07% CO, 0.01% H₂O, 0.01% NO₂
Mars Dust Storms

- High velocity winds and giant dust storms on occasion. Winds caused by large temperature differences between day/night and pole/equator and by CO$_2$ condensation/evaporation. *Dust loading* catastrophically develops into storms like a super Dust Bowl (no vegetation to block it).
Mars and Water

- Evidence for water in past: *runoff* and *outflow* channels. Near-saturation of atmosphere with water indicates presence of subsurface ice (permafrost).
Mars and Water

Right: Spirit and Opportunity Mars Rovers confirmed past existence of liquid water by discovering 'blueberries' (nodules from leaching of minerals to rock surfaces) that formed in rocks which had been eroded and layered by water.

Below: New deposits in gullies suggest water carried sediment through them sometime between 1999 and 2005.
Mars Evolution

• Original atmosphere of Mars was 600 times as dense, similar to present thickness of Earth’s atmosphere, and mostly CO$_2$. Where did this gas go?
• Water on Mars’ surface dissolved some CO$_2$, some froze into polar caps, some lost to catastrophic impacts.
• Lack of ozone layer led to UV dissociation of N$_2$ and H$_2$O and their loss from atmosphere.
• Cooling and solidification of iron core led to loss of martian magnetic field and to solar-wind stripping of atmosphere.
• Net result is Runaway Refrigerator effect.
• Mars is not necessarily too far from Sun to be Earth-like, but it is too small (not enough gravity, too rapid cooling) to prevent divergent evolution compared to the Earth.
Viking Experiments

- Gas exchange (GEX) — Soil sample placed in contact with a nutrient ("chicken soup"), Gas chromatograph analyzes the atmosphere for changes.
- Labeled release (LR) — Soil sample placed in contact with radioactive C$^{14}$ nutrient. Radiation detectors monitors the atmosphere for changes.
- Pyrolitic release (PR) — Soil sample incubated with radioactive CO and CO$_2$, then heated to 1023 K. Organic gases trapped, checked for radioactivity.

PR experiment designed without H$_2$O/nutrient:

- Liquid water cannot exist on Mars today, so it could trigger a variety of reactions that mask biological activity.
- The "chicken soup" might end up being poisonous to Martian organisms.
Viking Experiments

Results:

• GEX — Large amounts of O released, later attributed to inorganic reactions of soil and H\textsubscript{2}O.

• LR — Wetting produced rise in radioactivity, greater than observed on Earth. Second wetting produced no further response, suggesting that organic molecules in nutrient reacted with O-rich soil and produced CO\textsubscript{2}.

• PR — Radioactive C became part of the compounds in the soil sample. However, when soil sample pre-heated at high temperatures, same effect observed, although microorganisms should already have been killed.

Future Plans

• Phoenix – launched August 2007; will have robotic arm and onboard experiments

• Mars Science Laboratory – rover and experiments

• Mars Scout – inexpensive, small probes with limited missions

• Mars Sample Return, Astrobiology Field Laboratory and Deep Drilling Laboratory

Disadvantages of manned missions:

• Tremendously increased costs of transporting astronauts’ weight including food and life-support, including radiation shielding and water extraction and recycling

• Risks astronaut’s lives

• Danger of contamination

• History shows they will be based on political, not scientific considerations
Recent Mars Missions

- **Mars Global Surveyor 1996**
  - Thermal emission spectrometers

- **Mars Pathfinder, Sojourner rover 1996**
  - Mars was at one time in its past warm and wet, with water existing in its liquid state and a thicker atmosphere.

- **Mars Odyssey, Mars Surveyor Orbiter 2001**
  - Mars weather and climate
  - radiation hazards (martian radiation environment experiment)
  - gamma-ray spectrometer subsurface chemistry and water
  - thermal emission imaging system for detecting past water (hematite)

- **Mars Rovers: Spirit and Opportunity 2003**
  - Exploration for evidence of water

- **Rosetta**
  - Mars and asteroid flyby

- **Mars Express**
Did Life Once Exist on Mars?

SNC meteorites: unusually young ages, formed on a planet, blasted into space and exposed to cosmic rays after formation. Hard to blast matter off Mercury, Venus or Earth into Earth-crossing orbit, implying Mars or Moon origin. Trapped gases nearly identical to atmospheric composition of Mars. Three groups of SNC meteorites:

1. formation age 4.5 Byrs, impact age (transit time) 15 Myrs;
2. formation age 1.3 Byrs, impact age (transit time) 12 Myrs;
3. formation age 170 Myrs, impact age (transit time) 3 Myrs.
**Did Life Once Exist on Mars?**

Recently, a NASA team announced possibly detecting evidence of former life in ALH 84001, which landed in Antarctica 13,000 yrs ago. Evidence associated with *carbonate globules*, spherical crystals formed as carbonate precipitates from liquid water permeating the rock 3.6 Byrs ago:

- Carbonate grains have a layered structure, indicating biological activity.
- Carbonate grains contain shapes resembling Earth bacteria, 1/100 thickness of human hair, the same size as the smallest known Earth bacteria.
- Carbonate grains contain biominerals, possibly formed as a result of biological activity (magnetite, pyrrhotite, and greigite).
- Carbonate grains contain complex polyaromatic hydrocarbons (PAH) whose concentration increases with depth, implying terrestrial contamination unlikely. These PAHs differ from those observed in other meteorites or cosmic dust.
- Coincidence of 3.6 Byr globule age with the presence of liquid water on Mars.

**BUT:**

- There are nonbiological ways to produce layered carbonates.
- Extremely small size of nanobacteria-like shapes disturbs biochemists, as there is no evidence of cell walls, reproduction, growth, or cell colonies.
- $^{32}\text{S}/^{34}\text{S}$ higher than in Earth life.
- Discovery of terrestrial microorganisms in meteorite shows that some contamination has occurred, and could explain the PAH evidence.
- Previous claims of “life” in meteorites have always proved false.