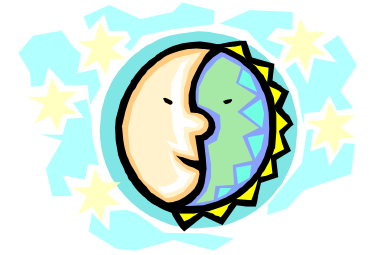


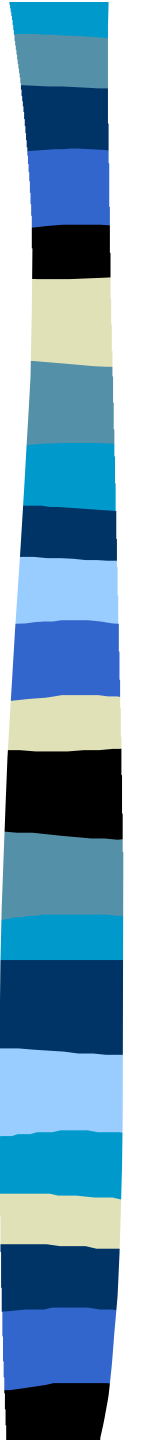
## *Water in the Solar System*

### *Water on Mars*

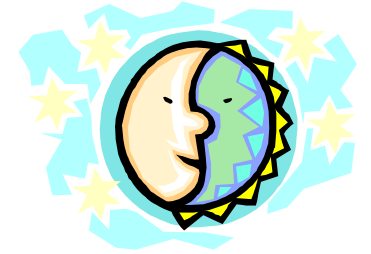


#### ■ Major points:

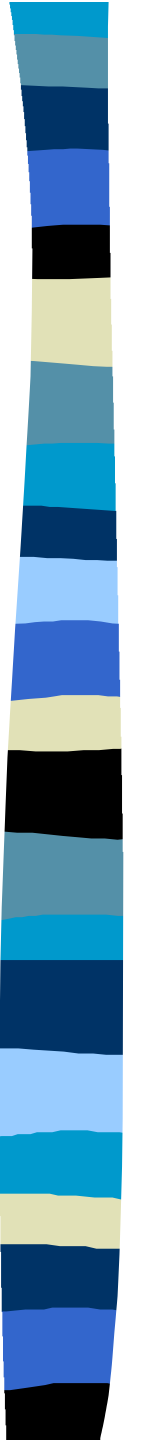
- Mars is about 1.5 times farther from the Sun than Earth
  - Should have formed with greater percentage of water, by volume, than Earth.
  - About 50% less sunlight, so colder than Earth.
- Mars' atmosphere is very thin
  - Pressure comparable to Earth's at about 30km altitude.
  - Liquid water is unstable everywhere on Mars' surface.



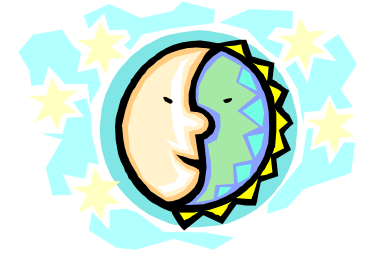
## *Where is the water on Mars?*



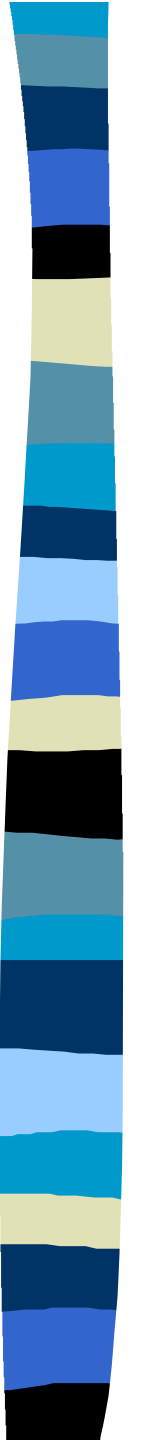
- Atmosphere
  - Only about 1 precipitable micron of water vapor today.
- Polar caps
  - Amount of water depends on % of water, dust and CO<sub>2</sub> ice.
  - Probably equivalent to between 6m to 30m distributed globally.
- Subsurface
  - “Megaregolith” may have pore volume equivalent of hundreds of meters distributed globally.
- *The above values are uncertain because the history of water on Mars is not well understood.*



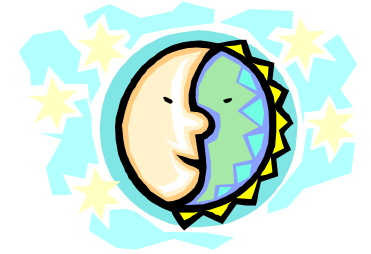
## *What about the past climate?*



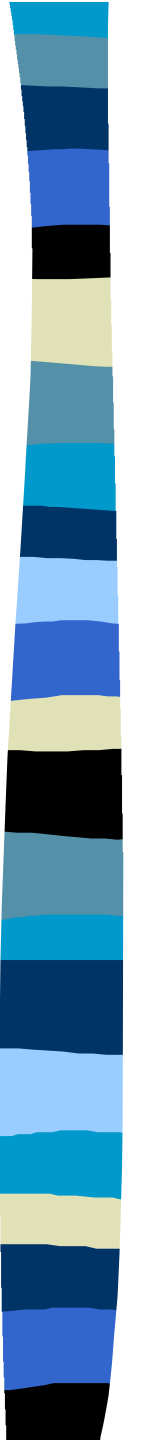
- Was ancient Mars warm or cold? Was it wet or dry?
  - Depends on Perspective
    - Is the Antarctic warm or cold? (there are streams, lakes, and a nearby ocean).
    - Is the Sahara wet or dry? (there are intermittent channels, lakes and a “nearby” ocean)
- Let us define a “warm and wet” planet as one with a climate that will allow liquid water to exist somewhere on the surface either perpetually, seasonally, or perhaps over longer time scales (such as ice ages).



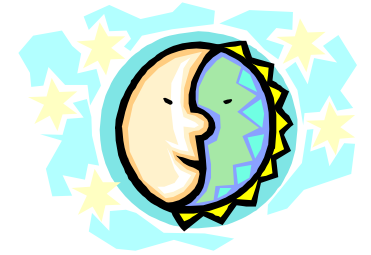
## *Evidence for water on ancient Mars*



- Channels
  - “Valley networks” - river-scale channels in narrow valleys and canyons.
  - “Outflow channels” - very large “catastrophic flood” channels, similar to dam failures.
- Erosion of ancient craters
  - Are they simply buried, or were they eroded by rainfall and filled in by sediment?
- Northern Lowlands
  - Was there an ocean in the northern plains?

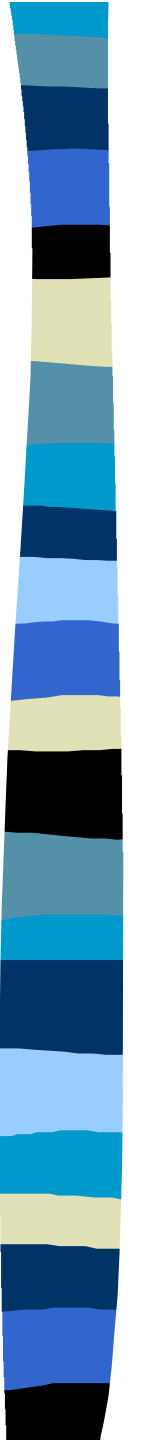


# *Valley Networks and Outflow Channels*

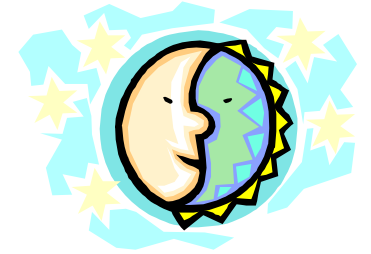


## ■ Observations

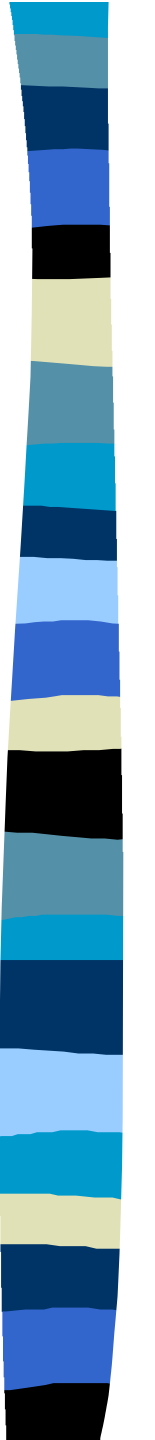
- *Most* valley networks show no actual channel on their floors.
  - Led some to suggest waterless processes for their origin.
  - Exceptions suggest flowing water or other fluid.
- *Most* channels appear to start in the subsurface.
  - Valley networks - “groundwater sapping.”
  - Outflow channels - Collapse of underground reservoirs.
  - Exceptions suggest rain or snow with surface runoff, or spillover of lakes.



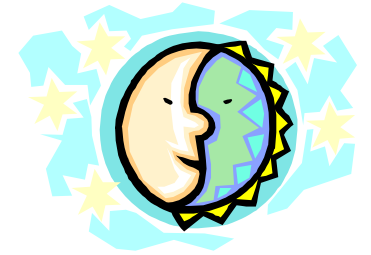
## *Erosion of Ancient Craters*



- Ancient craters show various amounts of degradation and styles.
- Large impact basins may tell us more about the very early Martian climate:
  - Cassini Basin - a largely “intact” rim.
    - Not breached by channels, yet there may be some lake sediment in its interior.
  - Ladon Basin - degraded, nearly destroyed multi-ringed basin.
    - Valley networks flowed into the basin interior through the rim mountains.
    - One outflow channel flowed into the interior, and another flowed out the other side.
  - Argyre Basin - very degraded, rugged rim deeply eroded by channels.
    - Very long valley networks cut through rim.
    - Layered sediments in interior may be lake sediments.
    - Outflow channel flowed out of basin, possibly carrying sediment out of basin.



## *Northern Lowlands*



- The margins of the northern plains show subtle features similar to ancient lake shorelines on Earth.
  - arcuate ridges, similar in shape to beaches
  - terraces, similar to wave-eroded seacliffs
  - mountains with flat-topped “aprons” around them, similar to wave-eroded islands