

Water on Mars

Today, low pressure prevents liquid water from being stable on the surface, but substantial reservoirs of water at the poles as ice and (?) in the subsurface.

- was the water ever present as liquid - for how long, and how much?
- role in shaping landforms on Mars
- is any liquid water present *now* underground?

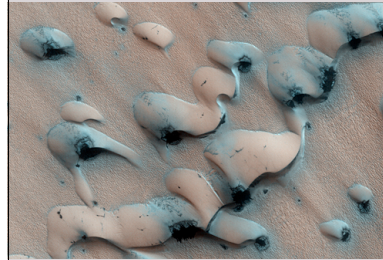
Evidence

- from orbit (morphology of landforms)
- from experiments on landers

Extraterrestrial Life: Spring 2008

Progress in imaging:

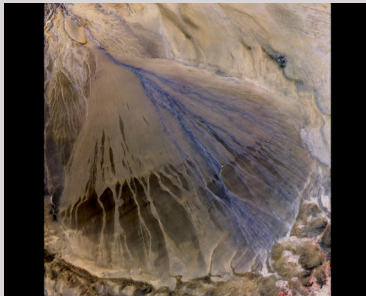
Viking orbiters: ~25m per pixel maps
Mars Global Surveyor: 1.5 - 12m per pixel
Mars Reconnaissance Orbiter: 30cm per pixel



Dunes at the South Pole from *HIRISE* imagery

Extraterrestrial Life: Spring 2008

Water vs lava features

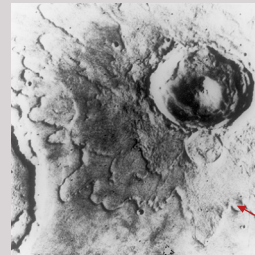


Alluvial fan in China

- running water
- standing water
- floods

Extraterrestrial Life: Spring 2008

Some craters on Mars seem to have been formed from impacts into water-rich terrain:



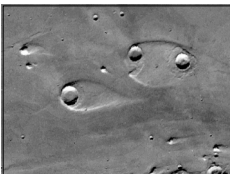
Yuty crater: ~20km across

Has an ejecta blanket that appears to have flowed across the surface - as if icy material was melted so the ejecta was fluid

older crater that the ejecta seems to have flowed around

Extraterrestrial Life: Spring 2008

Channels on Mars

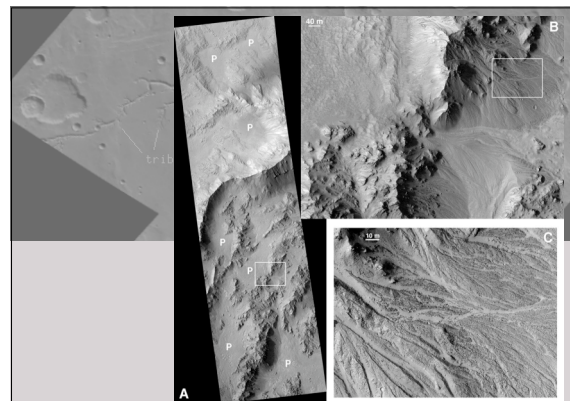


Oldest Martian terrain contains channels similar to river systems on Earth

- up to ~1km wide, and whole system up to 1000km long
- also very large *outflow channels* draining into the low northern terrain - 10s of km wide
- teardrop shaped islands strongly suggestive of fluid flow

Appearance of very old craters, and lack of small streams, argues against rainfall - may be groundwater flow

Extraterrestrial Life: Spring 2008



Extraterrestrial Life: Spring 2008

A Martian ocean?

Morphology on the boundary of the northern plains resembles an ocean shoreline

Was there an ocean on Mars?

Complicated by large topographic changes in last few billion years

Perron et al. (2007)

Extraterrestrial Life: Spring 2008

Transient water flows today?

Water today is not stable in liquid form on the surface... but if released from underground reservoirs would flow some distance before freezing / boiling off...

Evidence for such flows would suggest liquid water still exists in the sub-surface - possible abode for life

Martian temperatures are generally very cold, but can rise above freezing

Extraterrestrial Life: Spring 2008

Changes in the appearance of some gullies

Extraterrestrial Life: Spring 2008

Several instruments on board each rover that can analyze composition of soil and rocks. Small grinding tool can clean rocks prior to analysis.

Mossbauer spectrometer

- gamma-rays excite resonances within nucleus of some atoms (e.g. iron)
- emitted signature depends upon composition and structure of the material

Extraterrestrial Life: Spring 2008

Identify jarosite and hematite from spectra taken on rocks near the landing sites

Jarosite: hydrous sulphate of potassium and iron

On Earth, requires presence of acidic water to form (e.g. in mines)

Mars: suggests presence of water for an extended period - perhaps in a volcanic spring (?) - followed by an arid epoch

Extraterrestrial Life: Spring 2008

Summary: water on Mars

Today

- significant volume of water locked up as ice, and probably beneath the surface
- evidence for small surface flows, that may be due to transient water

Early Mars

- enough water to result in alteration of minerals
- likely extensive subsurface water / ice
- extensive channels (and possible ocean) but the relative role of water and lava is not clear... nor whether any water persisted for long periods

Extraterrestrial Life: Spring 2008

If water has been lost from Mars, where did it go?

Basic process:

- dissociation of H₂O by UV radiation in the Martian atmosphere (recall, no O₃ shielding)
- escape of the light hydrogen atoms to space
- oxygen reacted with rocks on the surface

Lower gravity means that atmospheric escape occurs much more readily on Mars than Earth

Mars may have had substantial amounts of liquid water for first ~billion years, might have subsurface water today...

Extraterrestrial Life: Spring 2008