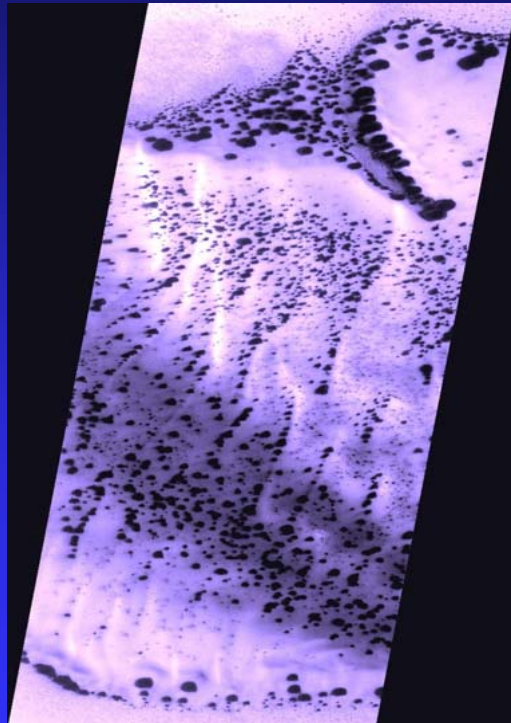


Surface refugia on Mars?



Eörs Szathmáry



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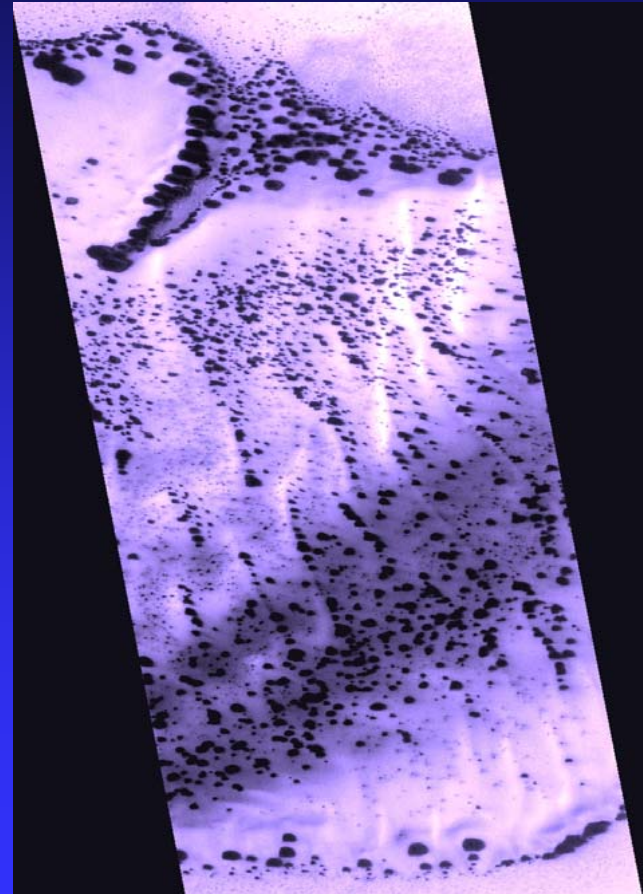
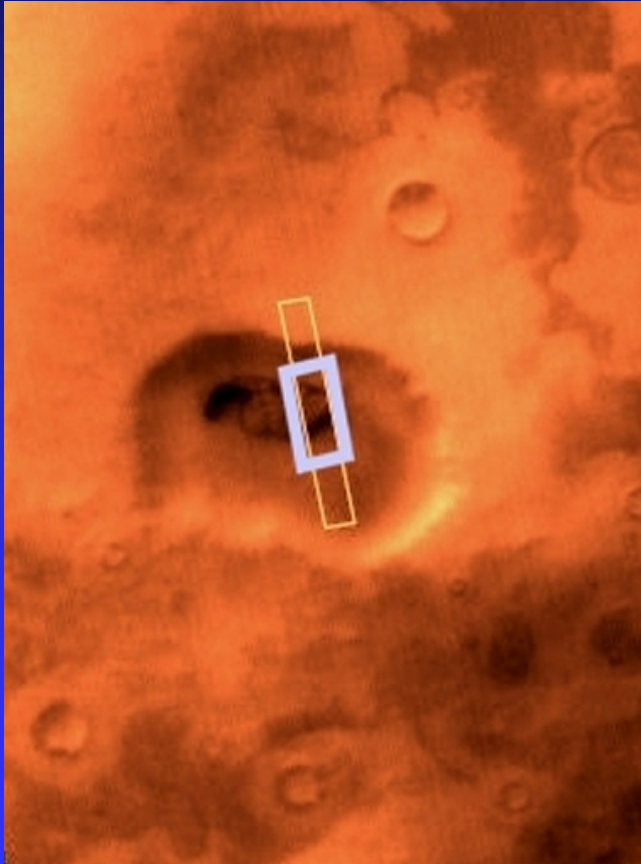


Collegium Budapest

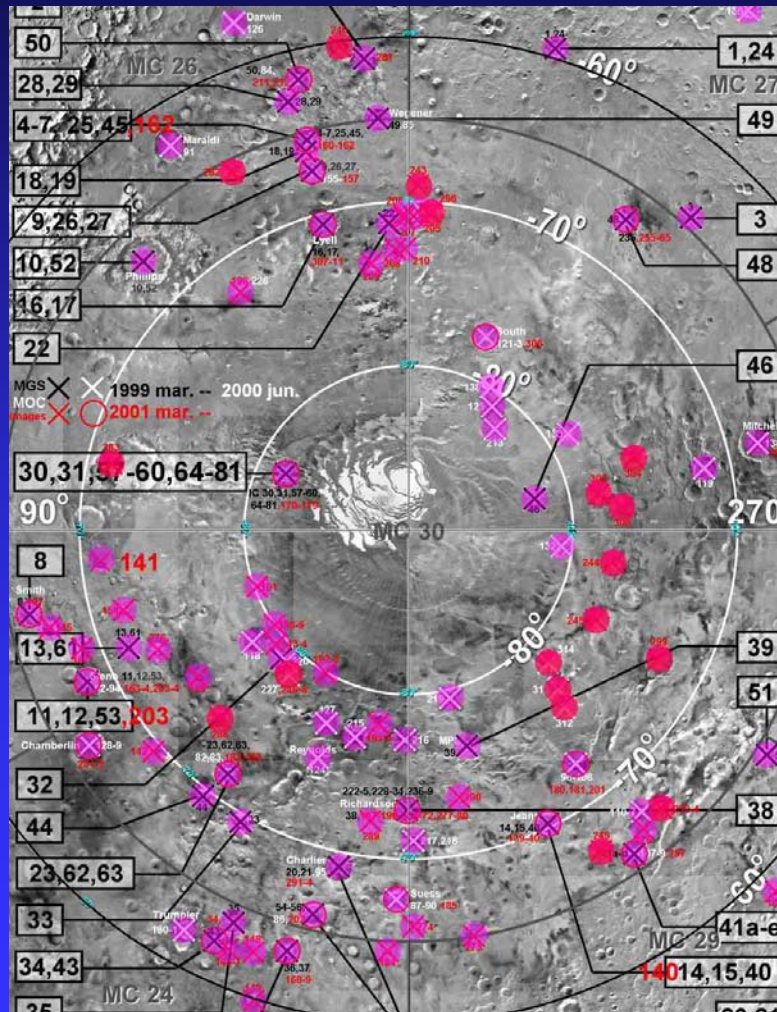


Eötvös University Budapest

Dark Dune Spots (DDSs): a candidate habitat (2001)?



Analyzed DDS sites in the south polar region (Mars Global Surveyor data)



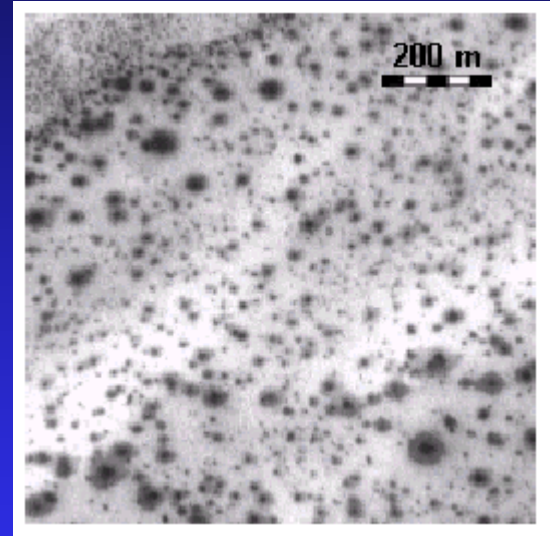
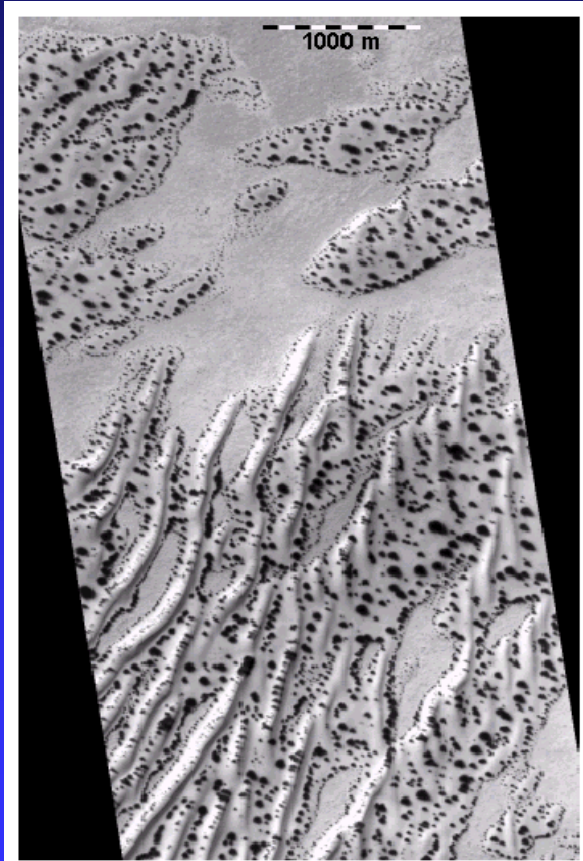
MOC images

Dark dunes

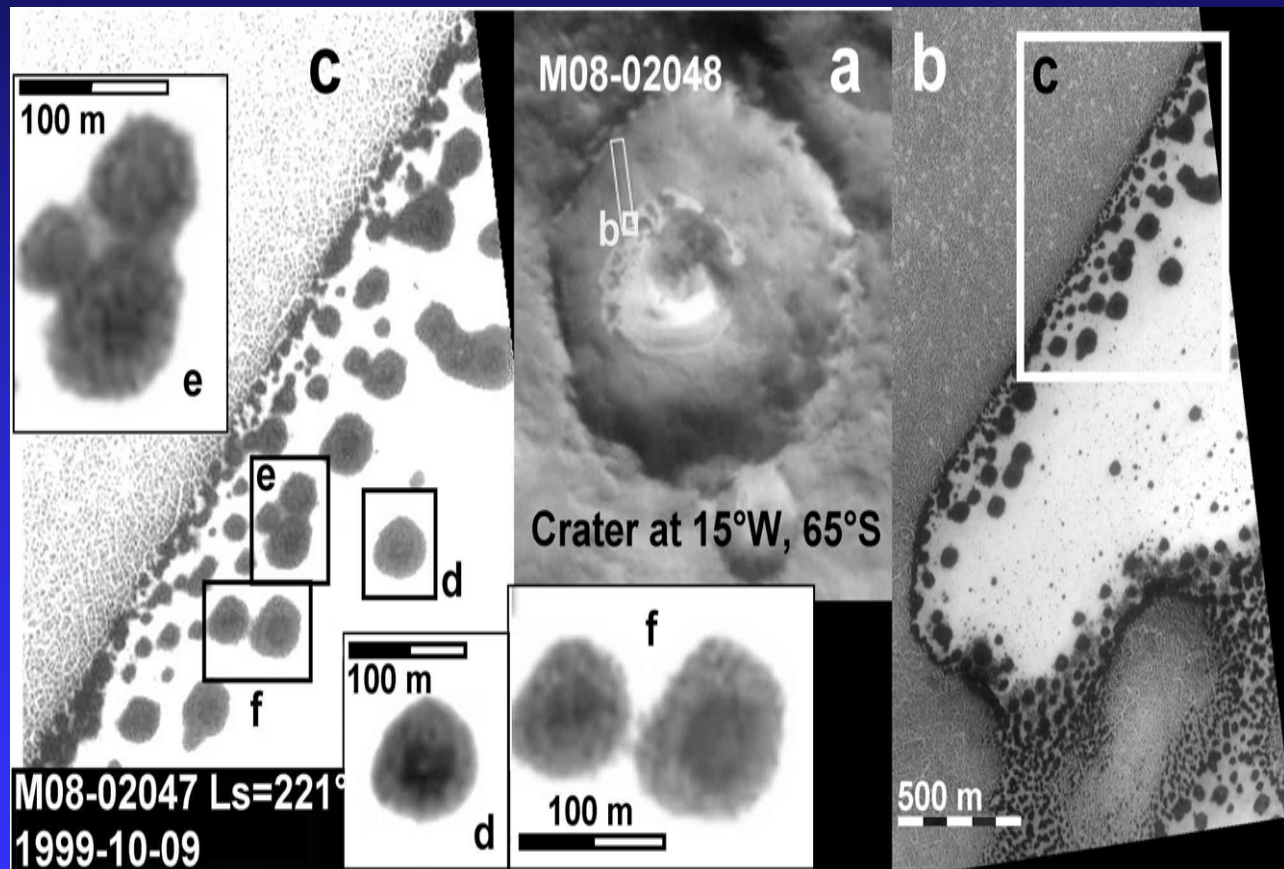


Malin Space Science Systems

DDSs stick to the dunes...



...and have inner structure



The most detailed source

DARK DUNE SPOTS: POSSIBLE BIOMARKERS ON MARS?

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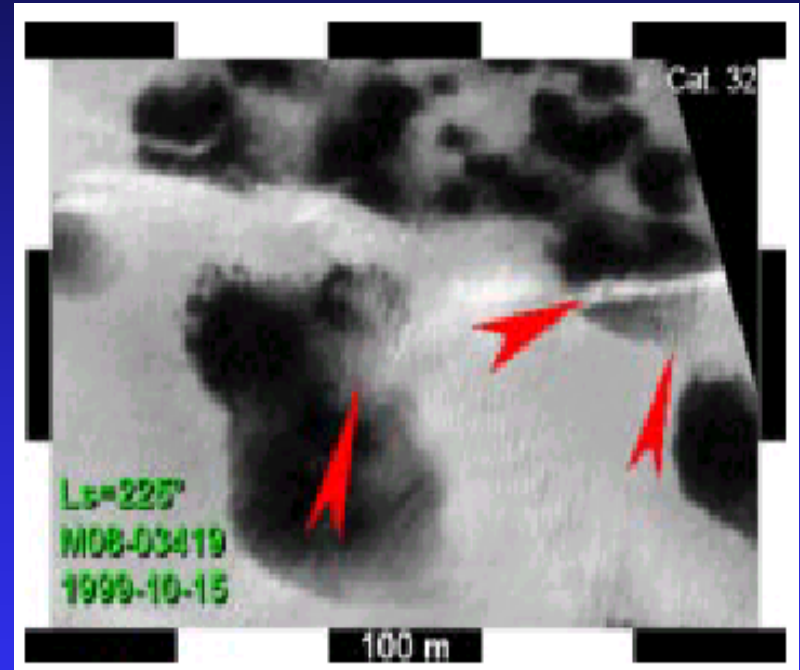
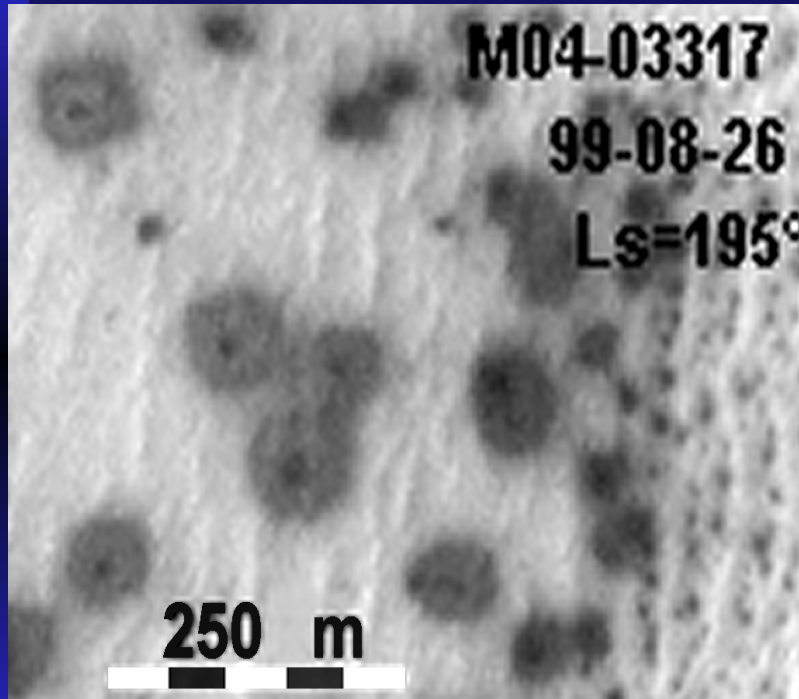
Origins of Life and Evolution of the Biosphere **33**: 515–557, 2003.

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Successful predictions of the Hungarian model (2001/2002)

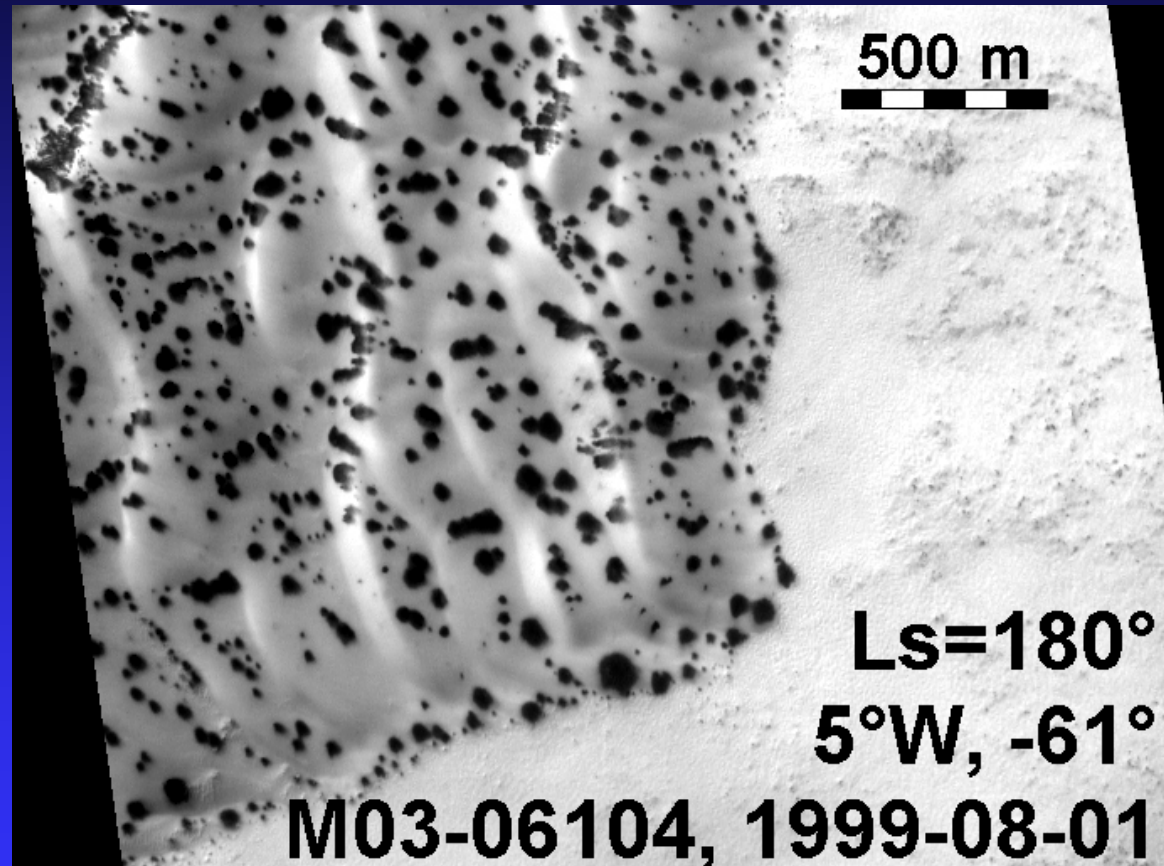
1. Significant amount of surface water ice in the south polar region
2. Frost/ice in the polar region is layered (water at bottom, CO₂ at top)
3. Transient melting on the surface of the dark dunes, causing
4. Flows from DDSs on slopes
5. Summer phantom DDS images

Simple frosting-defrosting does NOT work, because...



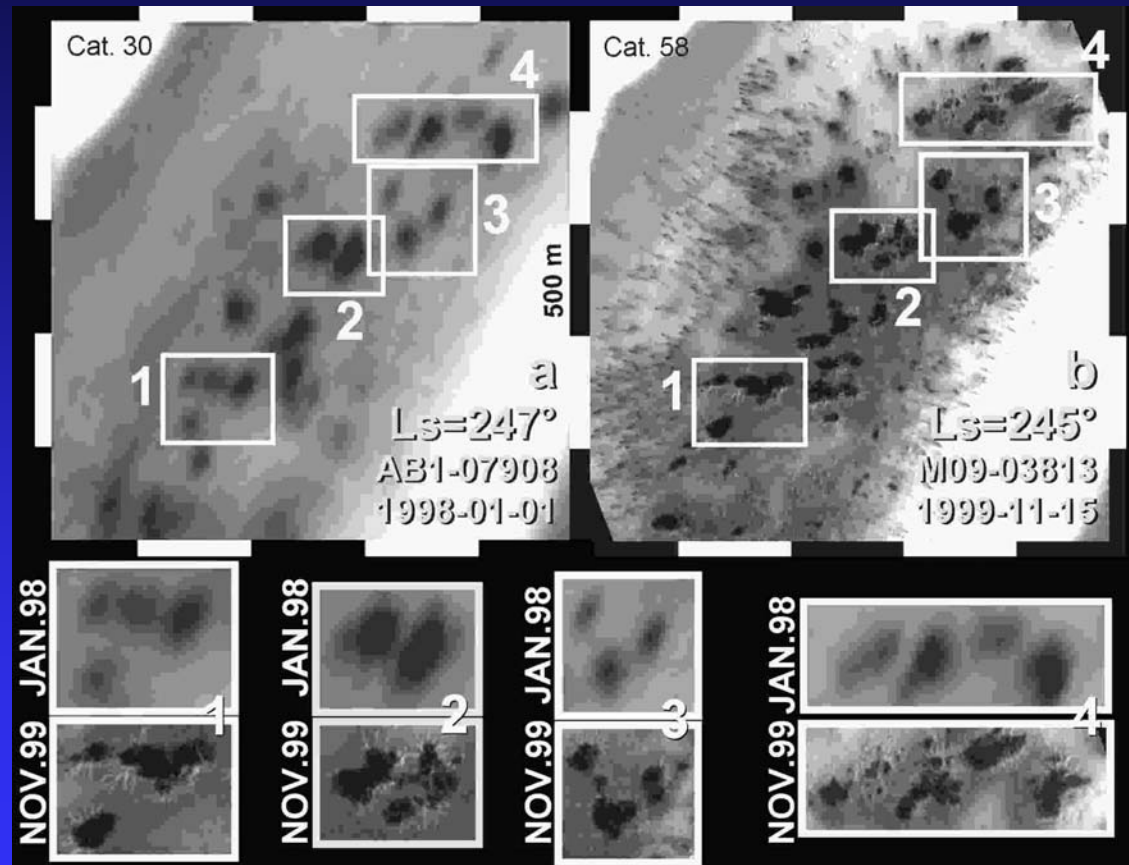
Spot formation begins at the *bottom*, not at the top!

Simple frosting-defrosting does NOT work, because...



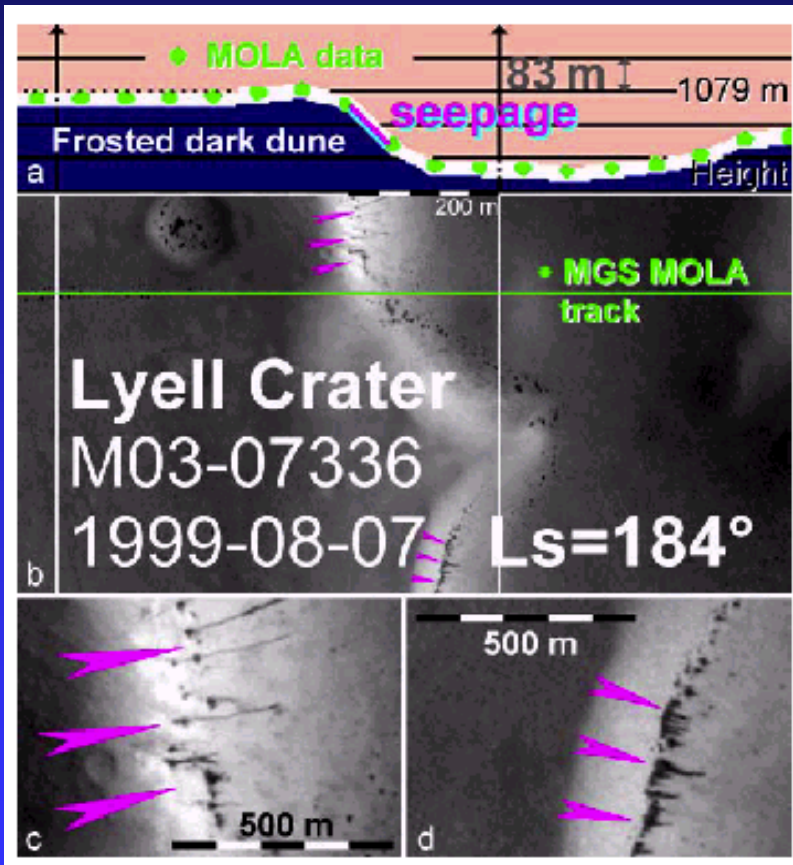
Spots do *not* develop on exposed sites!

Simple frosting-defrosting does NOT work, because...



There is annual recurrence (>75%) at the *same* sites!

Simple frosting-defrosting does NOT work, because...



- On slopes flows originate from the DDSs
- Which always flow downwards
- From elongated spots
- Gravitation is a formative cause

Flows may be due to water runoff

- The dry planet is much wetter than thought
- There is plenty of water:
 - ◆ In both ice caps
 - ◆ In the upper layer of the polar region (permafrost)
 - ◆ In liquid form in the gullies

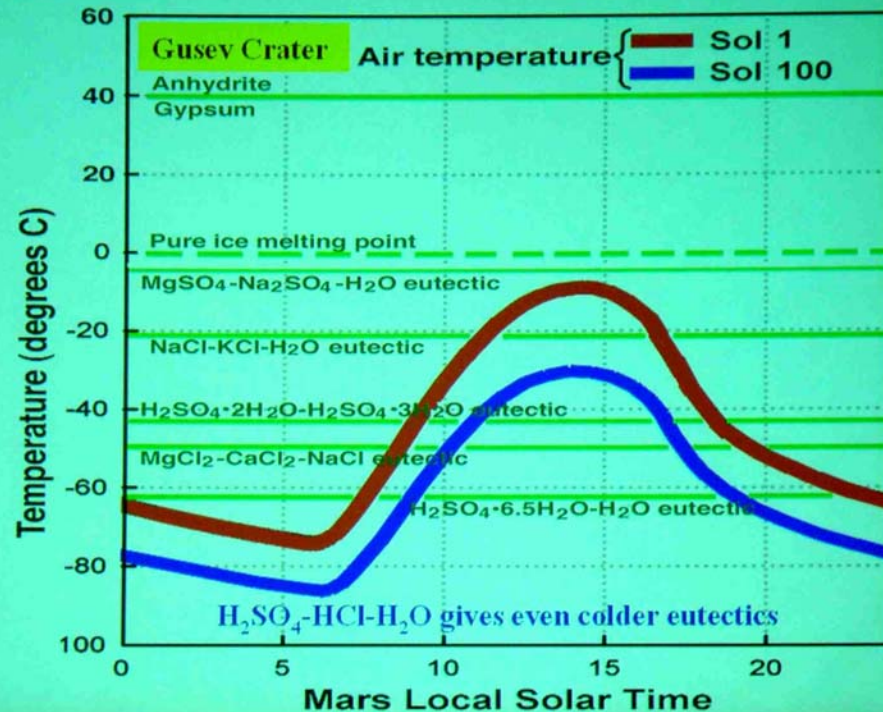
Clow's (1987) model for melting

- Melting occurs beneath the surface at temperatures well below freezing, because sunlight is absorbed at depth rather than at the surface, and this absorption is substantially increased by the incorporation of minor amounts of dust.
- Can occur for a wide range of snow properties and atmospheric pressures, and occurs under current conditions in mid-latitudes if dust abundances are greater than 1,000 parts per million by mass.

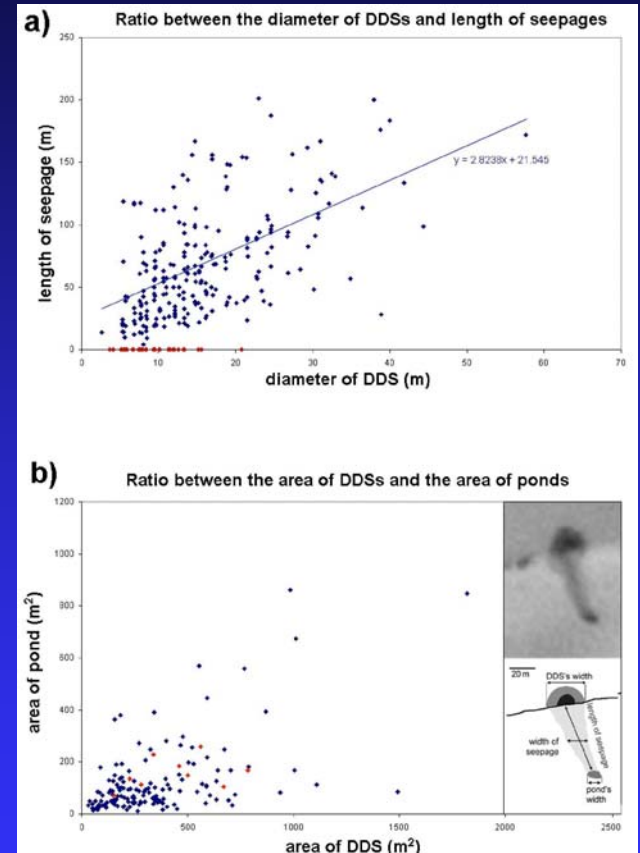
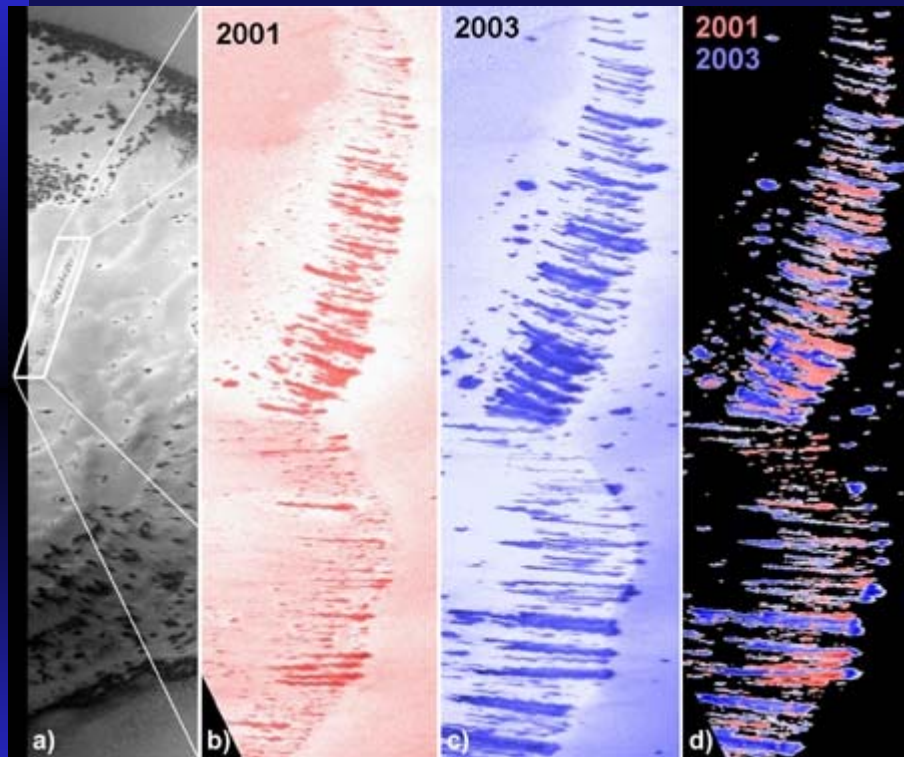
The effect of salinity on the melting point of water

Martian surface temperature cross melting thresholds of several brine systems expected on Mars

Models of diurnal temperature cycles courtesy of the MER teams: NASA/JPL/Cornell

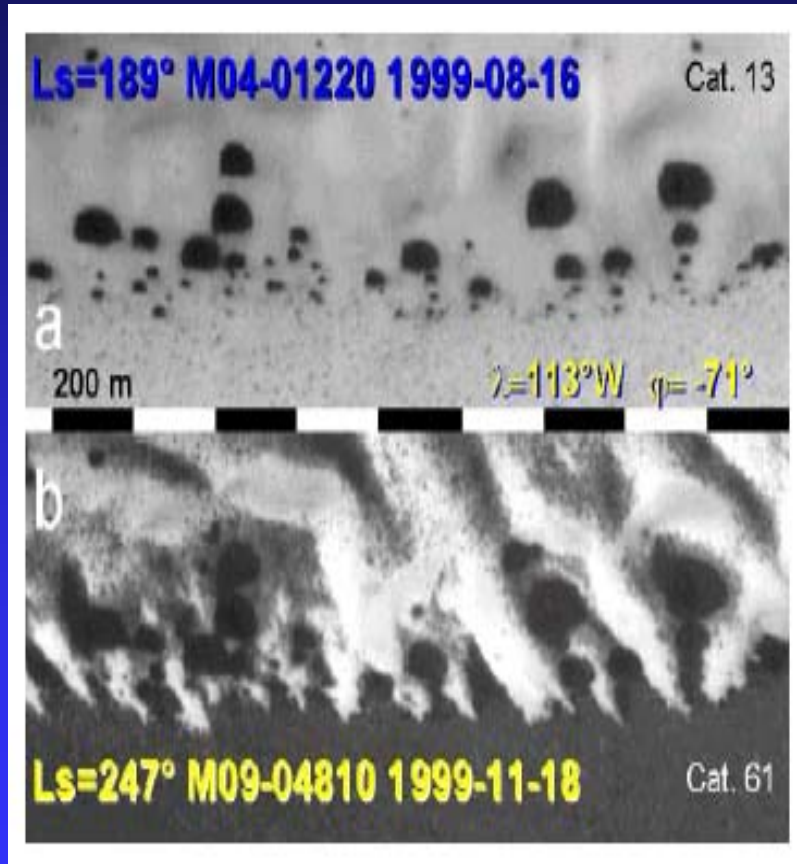


Yearly recurrence of seepage



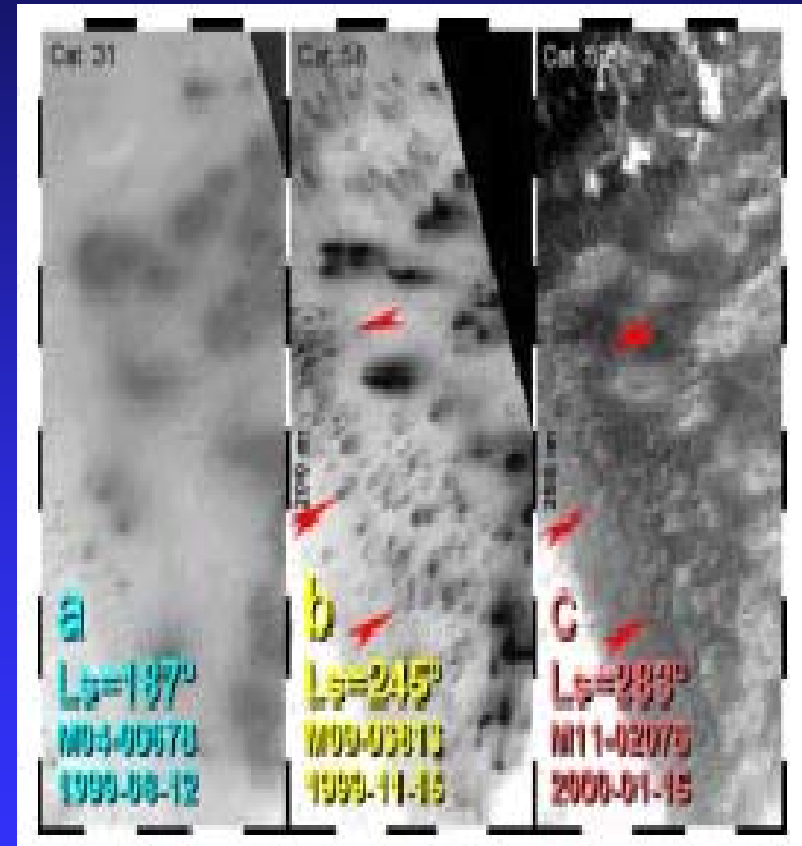
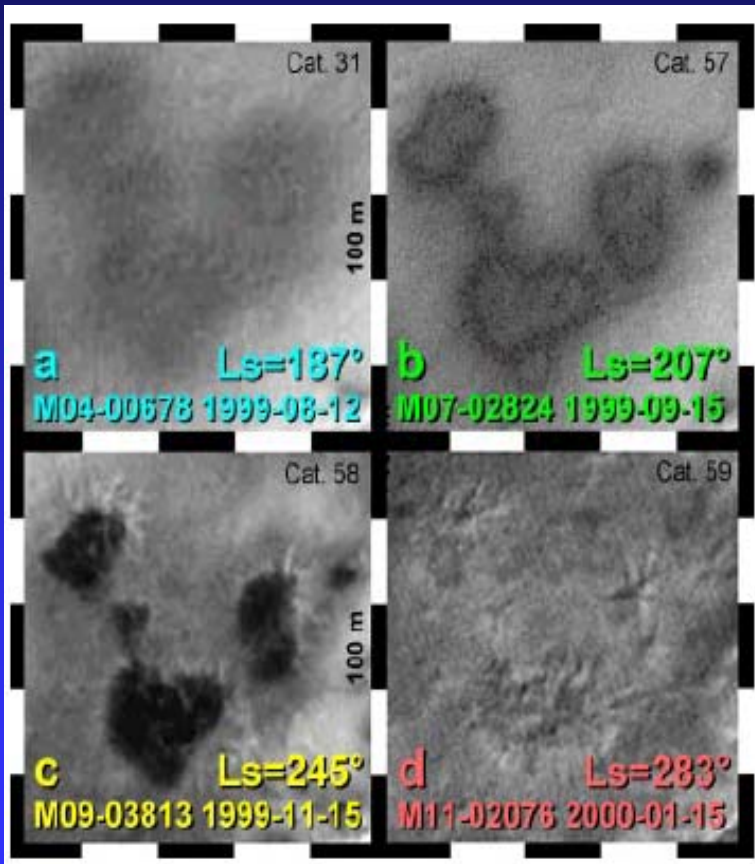
A strictly localized phenomenon

Layered frost on the dunes (2002)

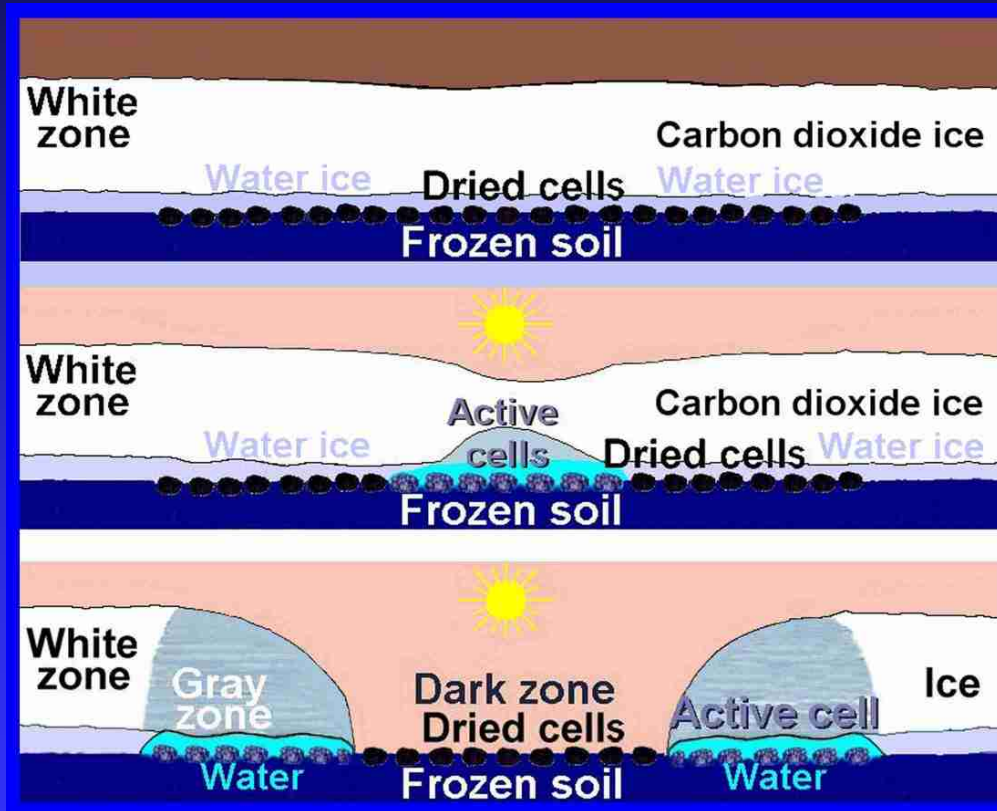


- Water ice, clathrate and CO_2 ice are deposited in that order
- Dunes are the first to frost and the last to defrost
- Total frost between 0.2-1 m (laser altimeter)

Dark spots are transformed to summer phantom spots



The biological hypothesis



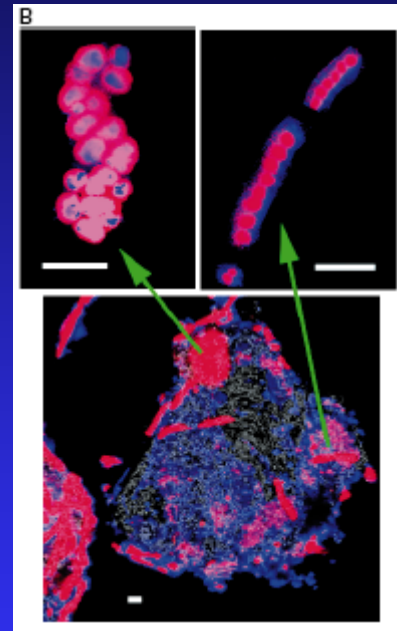
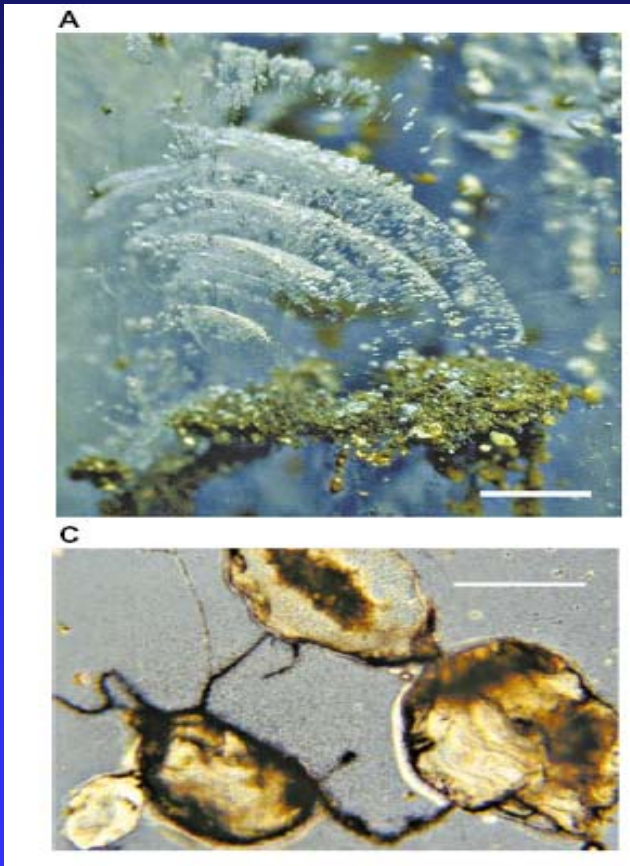
- Annual reactivation and growth of photosynthetic organisms
- Ice: excellent shield against cold, UV and dryness
- Organisms must go to dormancy before water ice shield melts through ('adaptive sporulation')

Looking for partial analogues on Earth (extremophiles)



- The Dry Valleys of Antarctica
- Cold, dry
- High UV due to continuous solar exposure
- Ozone depletion

Photosynthetic microorganisms



At the centre of a rich
consortium

Candidate analogue organisms

- Multiply extremophilic organisms
- Blue-green algae (cyanobacteria)
- Halobacteria
- Ecological consortia
- Another example: the cryptobiotic crust

Summary

- DDSs are a *potential* habitat for life on Mars today
- They may be *actual* habitats
- Earthly analogues are encouraging
- Chamber simulations have to be carried out
- Looking for pigments with appropriate spectroscopy (resolution, wavelengths!)
- **Sending landers to interesting sites!**

