# Human & Robotic Exploration in the search for life 2.0 in our Solar System

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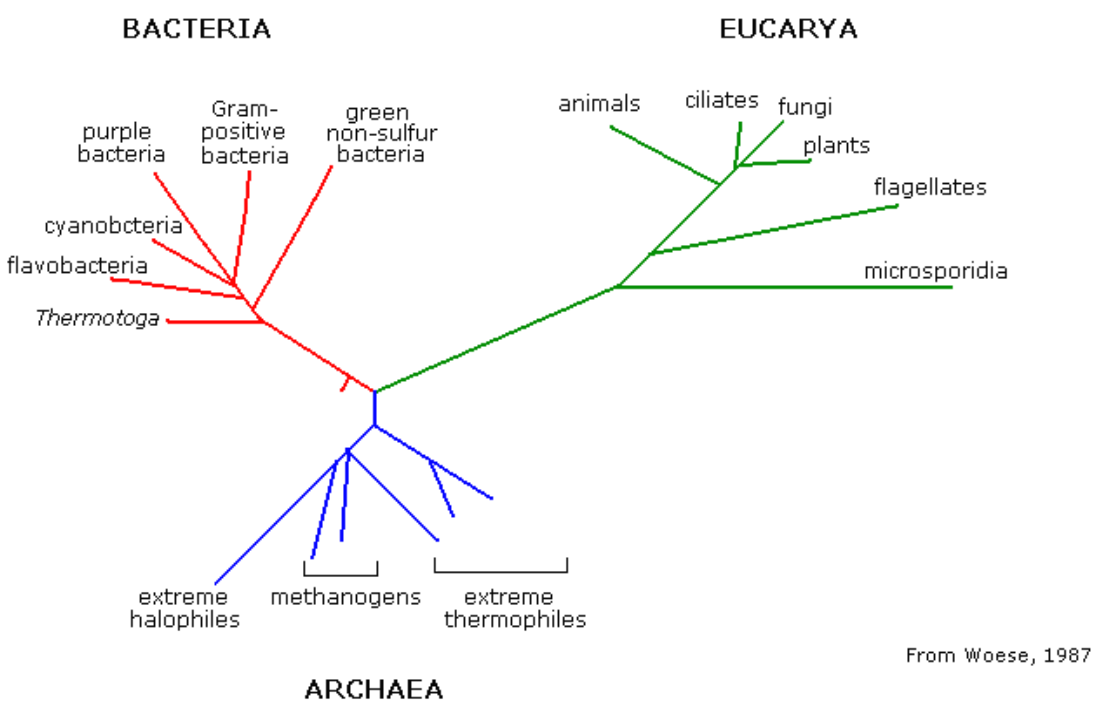
# The search for a second genesis of life?

⇒ comparative biochemistry (life 2.0)

⇒ life is common in the universe (yeah!)



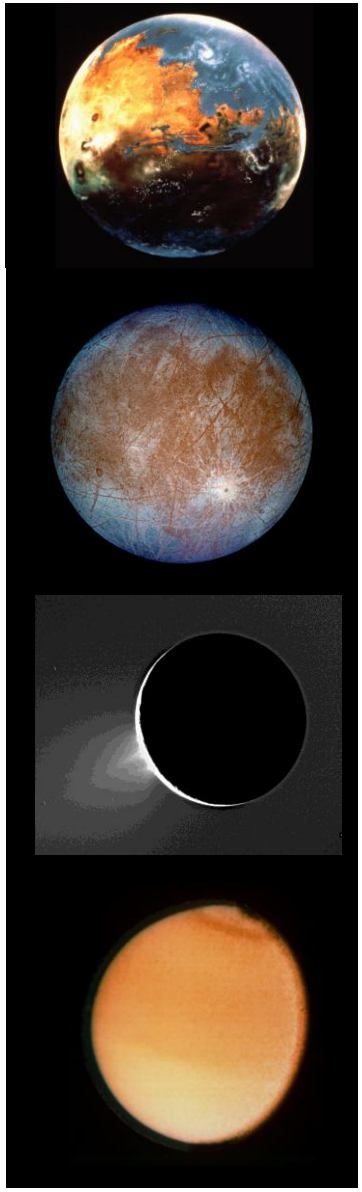

From Woese, 1987

Aliens:

not on our tree of life

# Where to look?

Increasing chance of life not related to Earth life



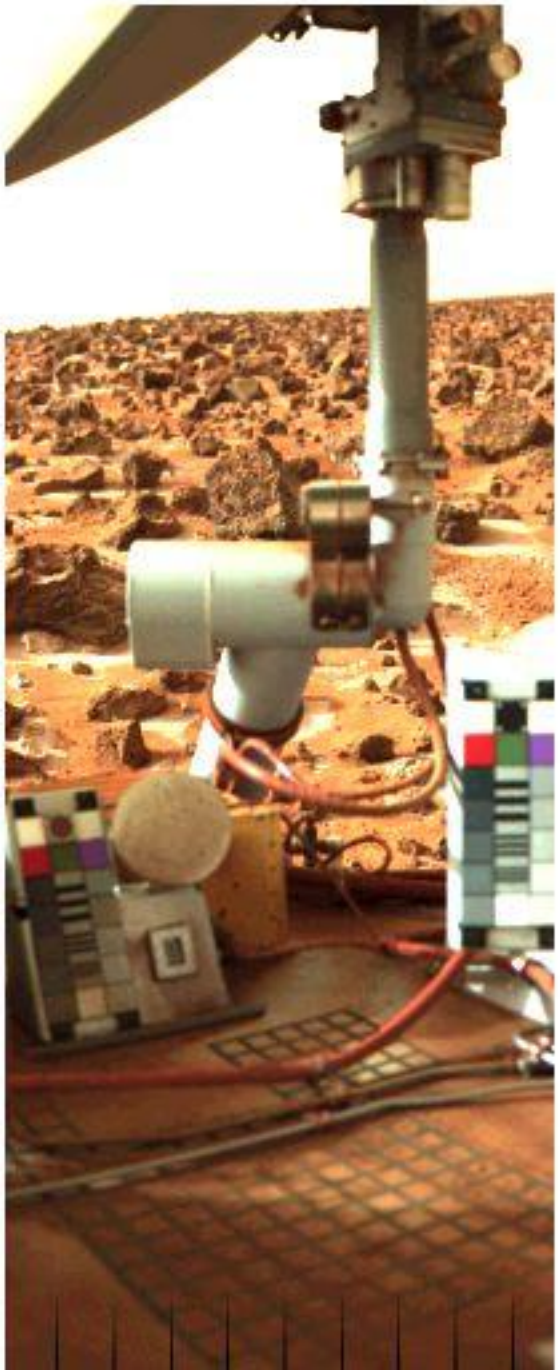
Mars: past liquid water, maybe organics (MSL will tell us soon)

Europa: has ocean,
No evidence yet of organics

Enceladus: has icy jet,
liquid water, organics, nitrogen
WOW!

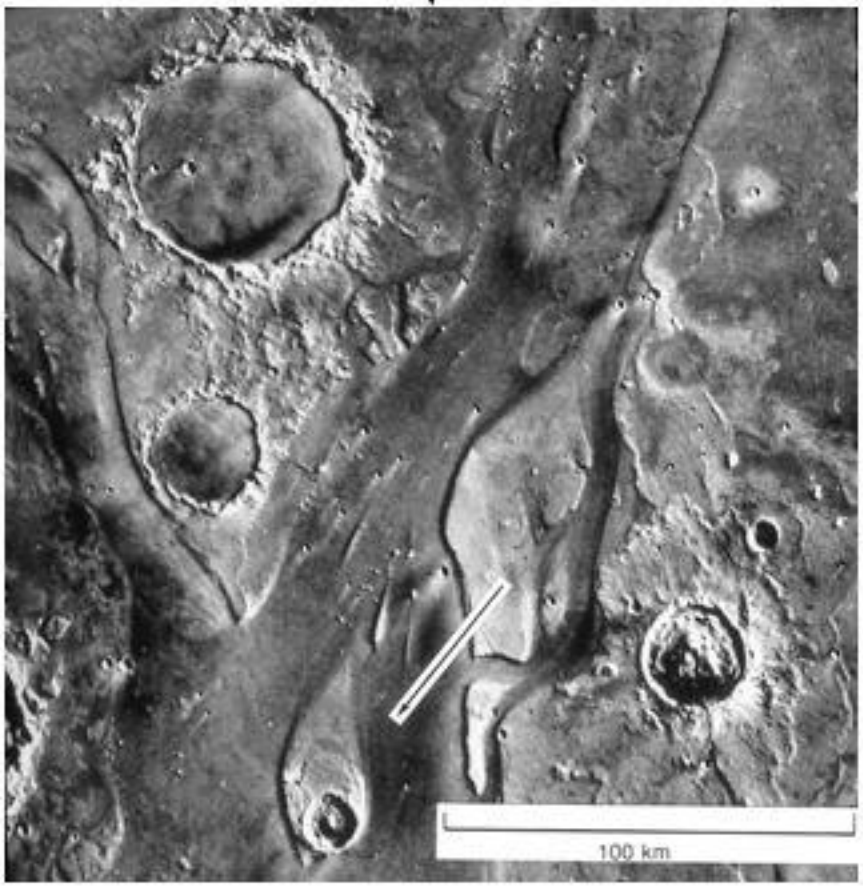
Titan: liquid - not water,
Lots of organics

# Viking:

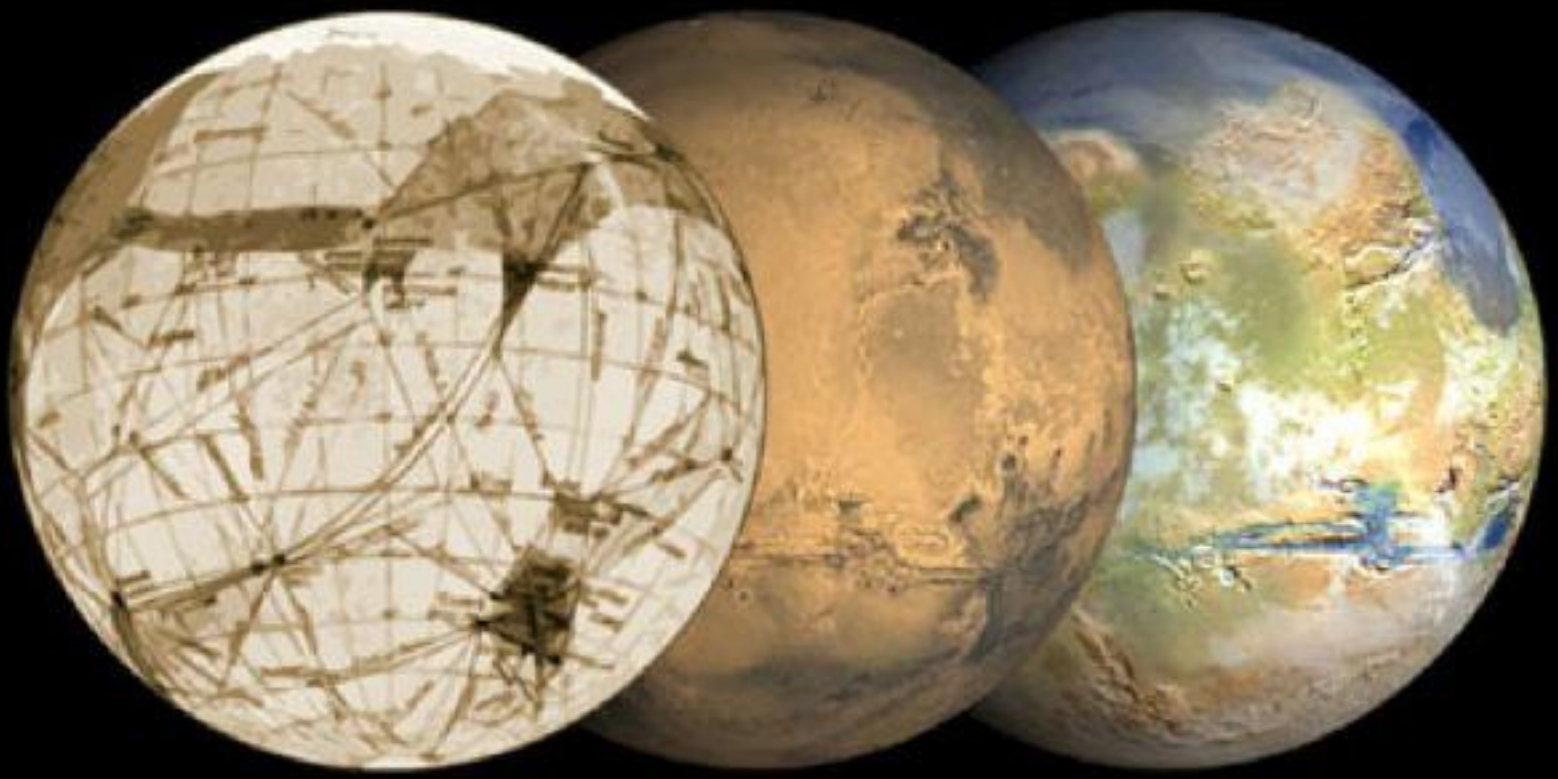


water frost on Mars

water flowed on the surface

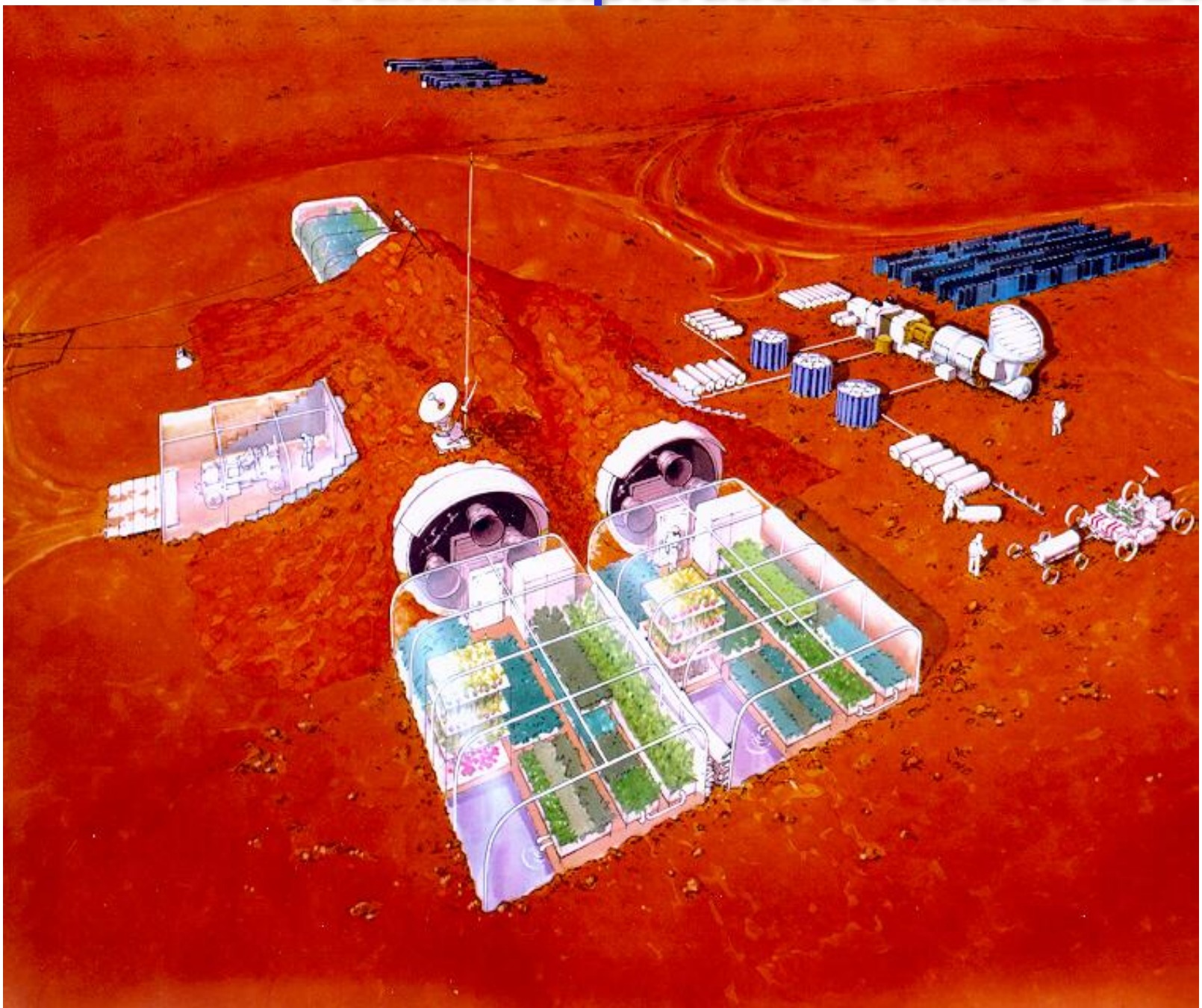


# Why Mars?



Evidence for past liquid water
Presence of an atmosphere with $CO_2$ & $N_2$
Potential for preservation of evidence of life

# Human exploration of Mars: 2025+



# Why Mars is important for human exploration?

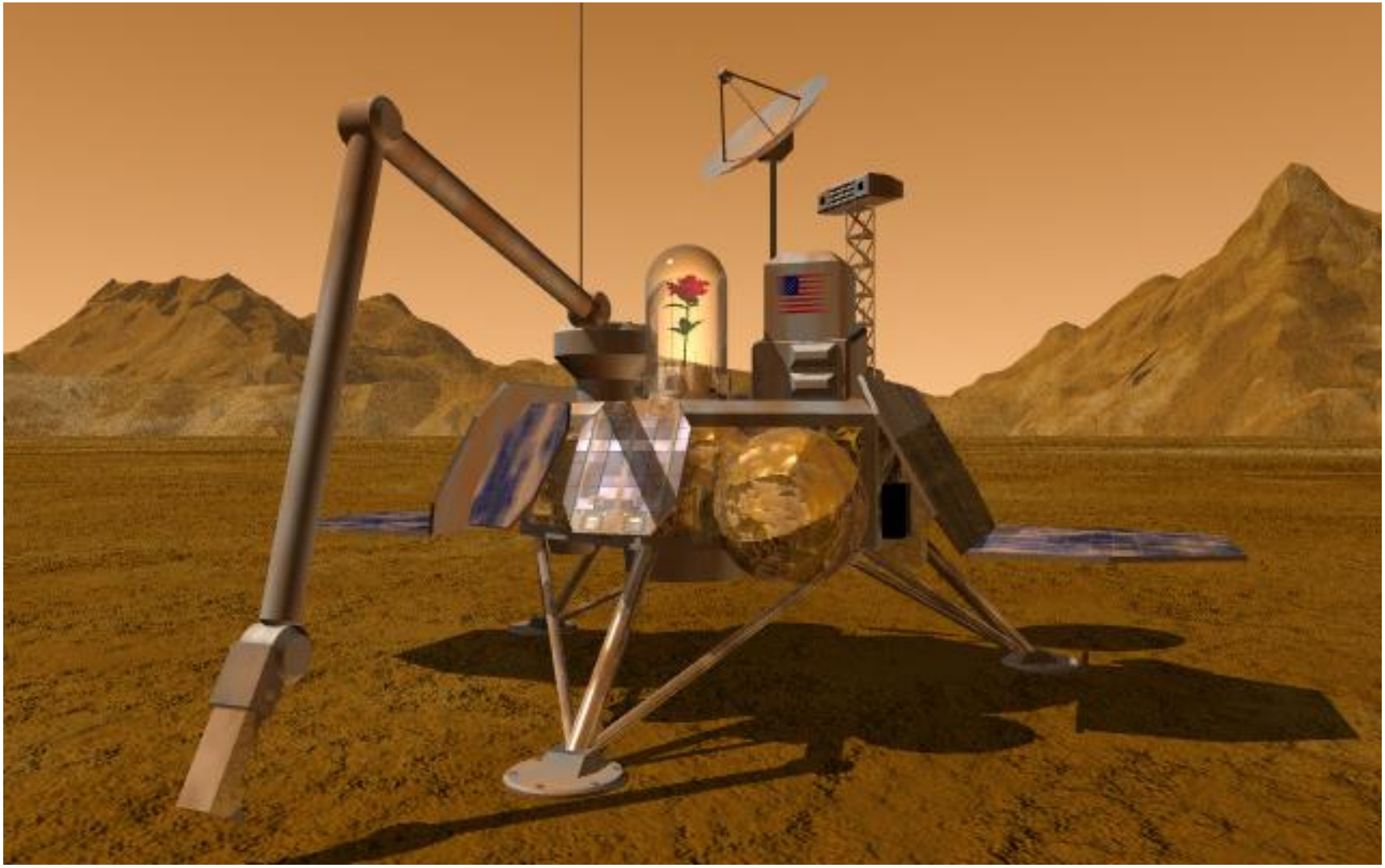
- Life, Past:
  did Mars have life, was it a second genesis

- Life, Present:
  can Mars support life, it is a place where humans can live and work

- Life, Future:
  can Mars have a biological future

# Near-term missions

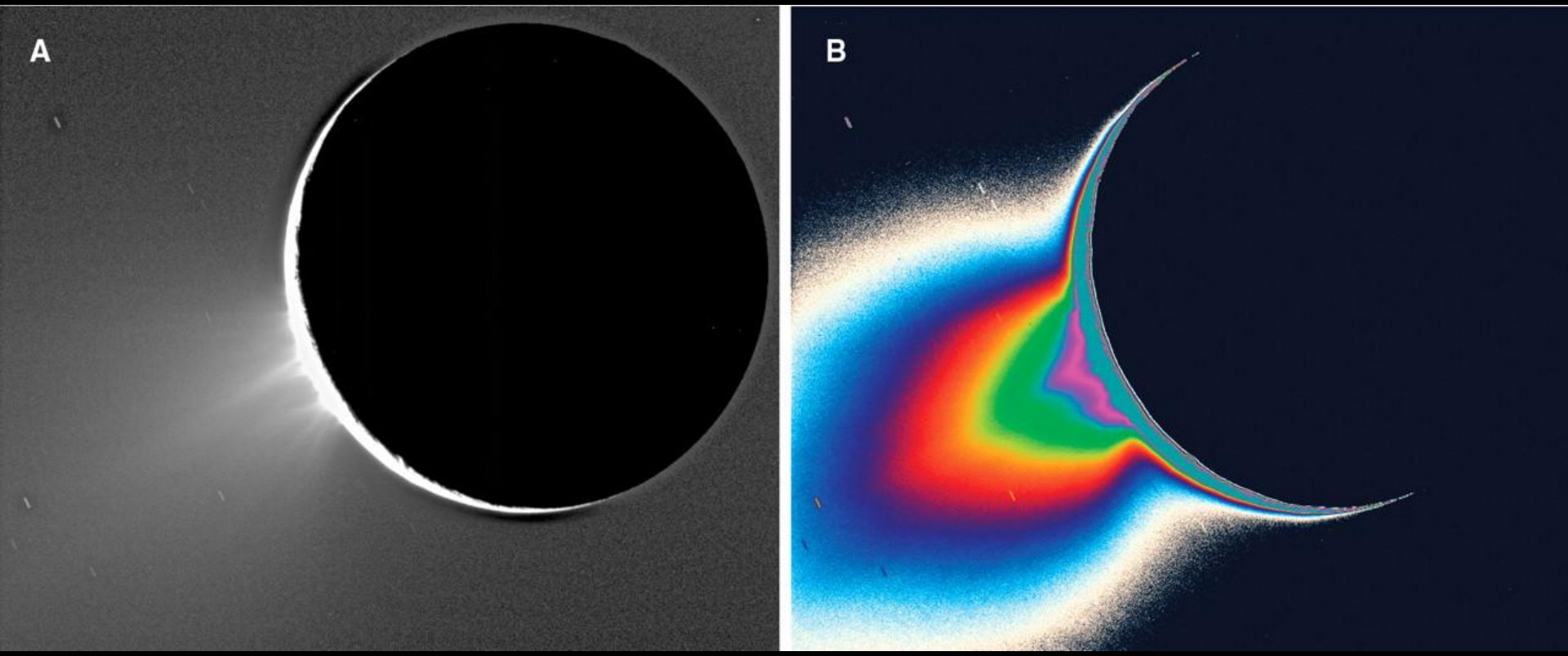
## Using the martian soil and atmosphere for a plant growth module



# Life to Mars

- An organism-level test of soil biohazard, environment, radiation, and martian gravity.
- A technical and programmatic basis for advanced plant-based life support systems.
- Provides a wonderful opportunity for public involvement (FTD: Flowers to Mars).
- Symbolic as first organism to grow, live, and die on another world.
- Helps diffuse back contamination issues for sample return and human missions.
- Biological precursor to human exploration.
- Consistent with planetary protection with no inadvertent forward contamination of Mars.

# Jets of $H_2O$ on Enceladus



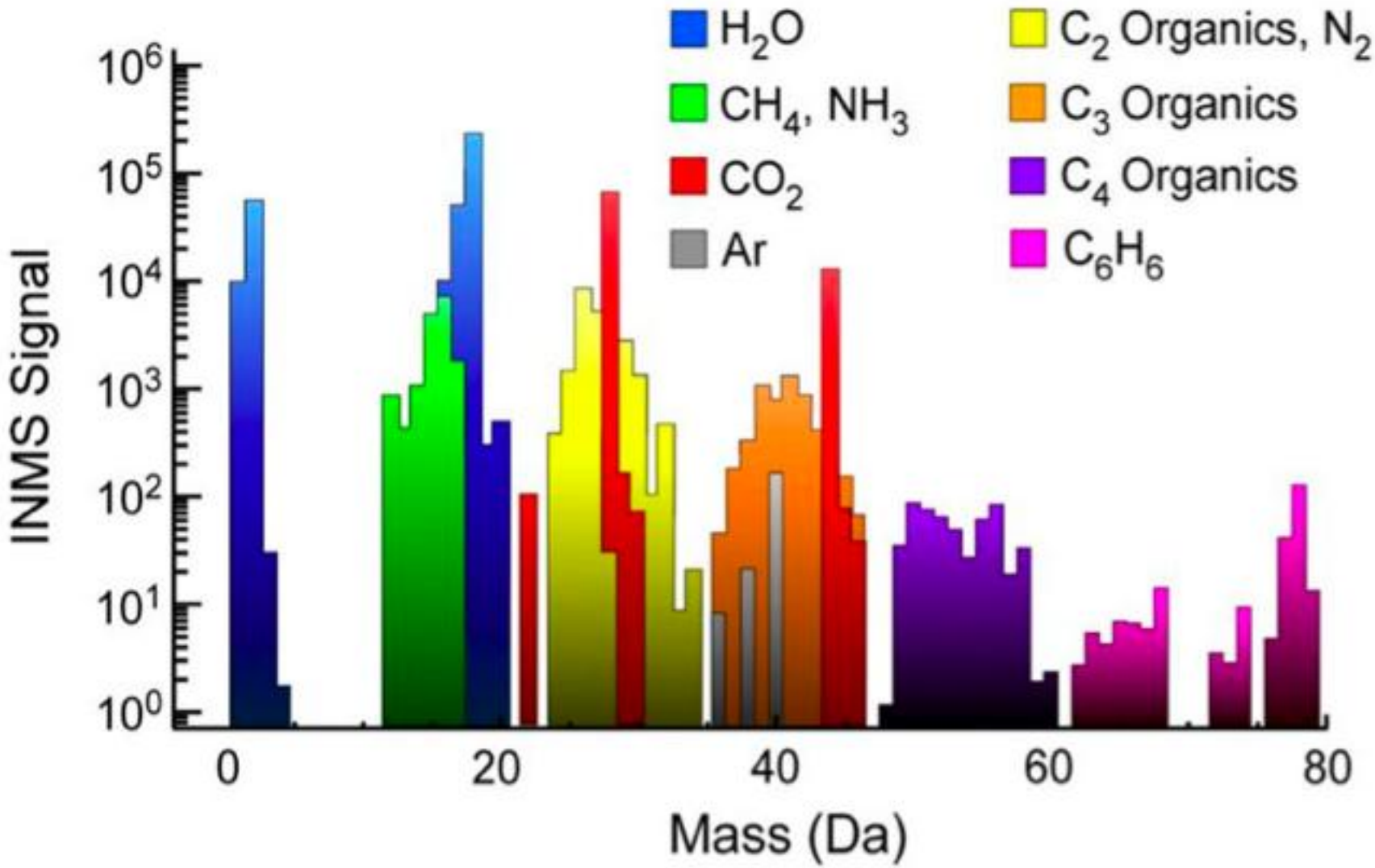
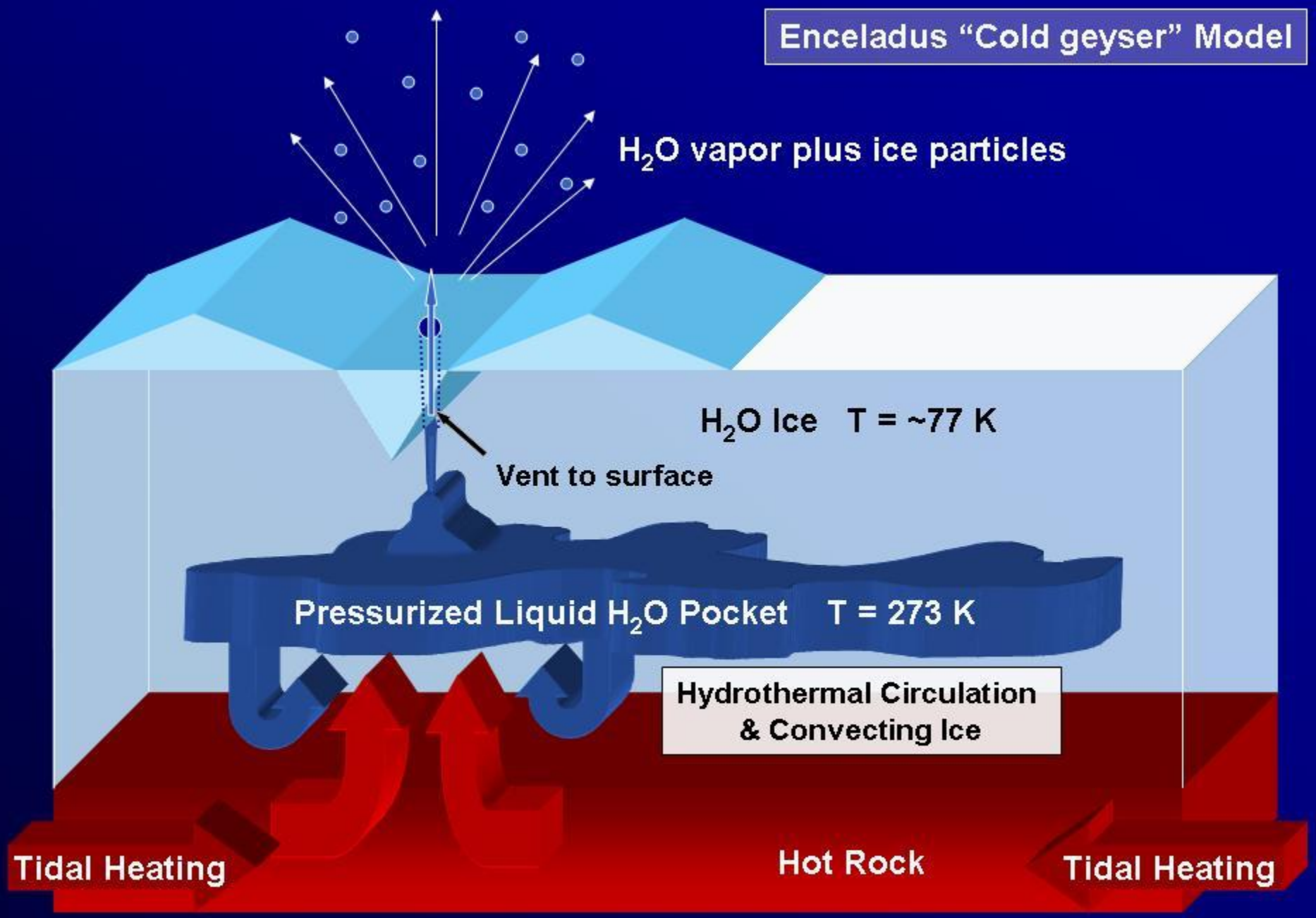



**Figure 22.18** Mass spectrum of the Enceladus plume from the October 9th 2008 flyby (Waite et al. 2009). The colors show contributions from various species and their breakdown products using the composition shown in Table 22.3.


Enceladus "Cold geyser" Model
$H_2O$ vapor plus ice particles
$H_2O$ Ice T = ~77 K
Vent to surface
Pressurized Liquid $H_2O$ Pocket T = 273 K
Hydrothermal Circulation & Convecting Ice
Tidal Heating
Hot Rock
Tidal Heating

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