

Venus Exploration and the Case for Astrobiology

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Why Astrobiology and Venus Exploration

- Understand terrestrial planet evolution within the context of habitability
- Similar early conditions, yet followed different evolutionary paths:
 - Global volcanic activity and early oceans
 - Earth evolved into the only known habitat for life
 - Venus evolved into a hostile environment for life
 - Runaway Greenhouse Effect and loss of ocean
 - Massive CO₂ atmosphere (90 bar)
 - Very hot surface temperature (~730 K)
 - Dry atmosphere with global cloud deck composed of sulfuric acid (H₂SO₄) particles

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Possibility for past/present life

- Evidence of life on Earth as early as 3.8 Ga
- Early ocean (2 Gyr duration) allowed for life to originate, e.g. near hydrothermal systems
- Inhospitable surface conditions forced life to retreat to atmosphere
- Arguments for possible microbial life in clouds (Schulze-Makuch et al. 2004):
 - Venus clouds: larger, more continuous, and stable than on Earth
 - Atmosphere in chemical disequilibrium, with H_2 and O_2 , and H_2S and SO_2 coexisting
 - Super-rotation of atmosphere enhances potential for photosynthetic reactions
 - Water vapor concentrations reach several hundred ppm in the lower cloud layer (40-50 km altitude)
 - Microorganisms found to grow at extreme conditions on Earth: pH, temperature, pressure, radiation – conditions within realm of Venus atmosphere