Analogs

Shallow Life

Disclosure: Until this week “deep” = 1-2m
Hypothesis: The last surface microbial communities on Mars were desert-dwellers.

High elevation Dry Valleys (frozen regolith)

Hyperarid core of the Atacama (soils/salt)
High Elevation Dry Valleys

- No signs of microbial activity in permafrost soils (**Cold limit of habitability?**)
- Microbial communities hiding away inside sandstone rocks (endoliths)
- Significant horizontal and vertical **variability** in ice content, geochemistry and biomass.
  - Different **types of ground ice** (vapor-deposited; buried glaciers; frozen snow; frozen lakes…)
  - **Ice content** can vary by >50% over 10s of cm (at least in the top few meters).
  - Extremely low levels of biomass that decrease with depth
Hyperarid core of the Atacama (soils)

- Lowest biomass soils on Earth. Significant horizontal and vertical heterogeneity
- Soil bacteria in survival mode; no growth
- Human and cross-contamination are a real and unresolved problem
- Good location to test geophysical tools to detect near-surface aquifers
Hyperarid core of the Atacama (salts)

- Evaporites (playas) are a long-term habitability record (Wet Atacama/Dry Atacama)
- Salts are the last refuge for life near the surface
- Evidence of entombed archaea found in c.a. 2-5 Myr salt layers (very uneven distribution down to 20 m depth)
Atmospheric Precipitable Water (mm) vs. Temperature (K)

- **Mars (85° N/S)**
- **Mars (Equator)**
- **Earth (South Pole)**
- **Earth (Atacama)**
- **Dry limit of habitability**
**Takeaways**

- **Shallow life** not possible today. Might have been possible in the recent past (Amazonian) but only in localized places (salts/ice).

- Horizontal and vertical variability over 10s of cm in biomass and resources.

- Worst-case biomass levels on Earth (Atacama) are best-case biomass levels on Mars (even in the subsurface).

- Reach vs resolution → The search for evidence of life will likely demand fine sampling resolution (uneven distribution of biomass over short vertical/horizontal scales). The extraction of resources (water) will likely require reach (maximize extraction volume).

- "**Intelligent drills**" needed for decision making (fast interpretative telemetry that provides clues regarding the nature of subsurface materials)—also applies to ground ice.

- 1-10 vs 100-1000

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**Life detection requires stringent molecular contamination control**