Recurring Slope Lineae (RSL) near candidate Mars 2020 landing sites

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HIRISE

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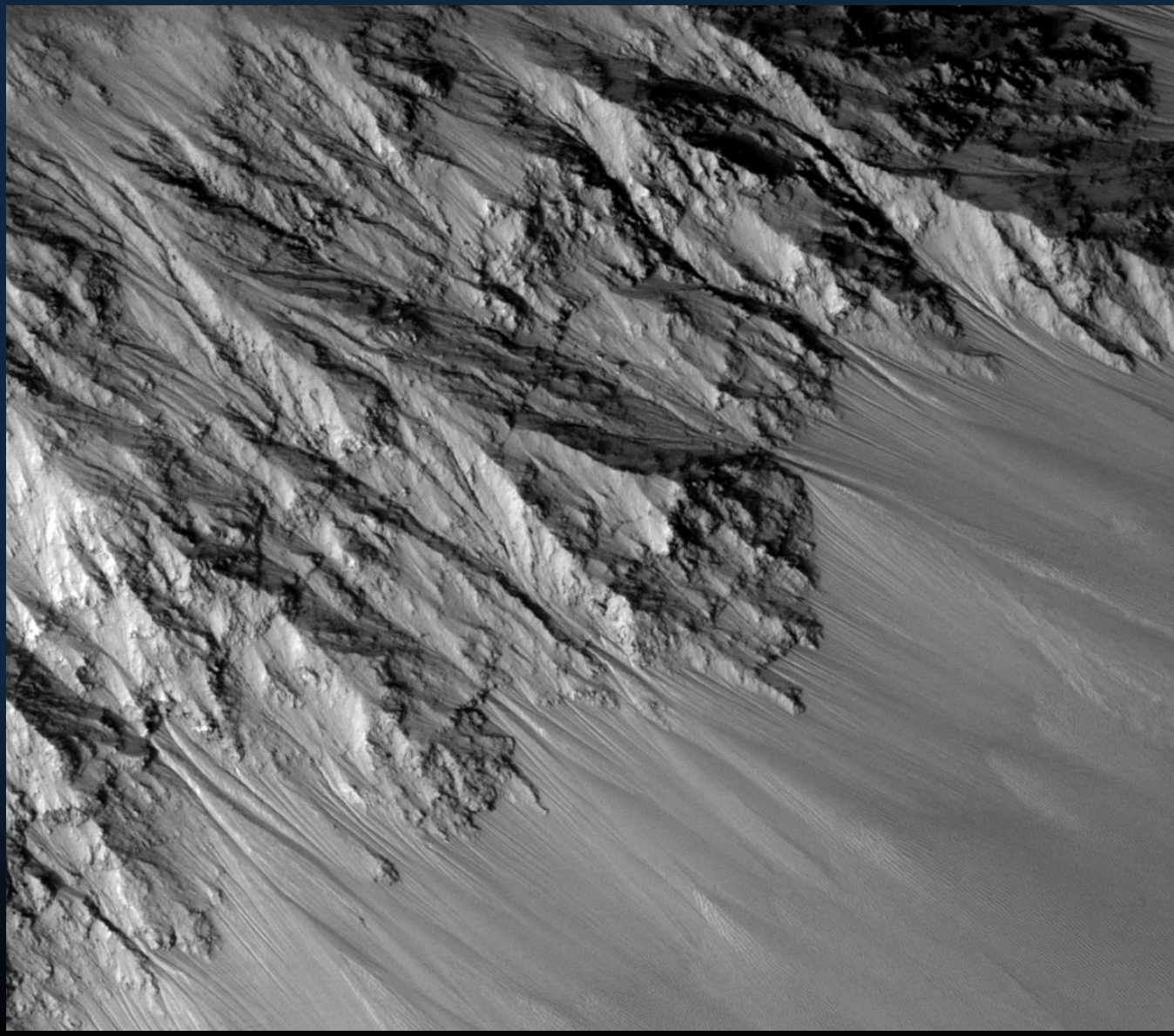
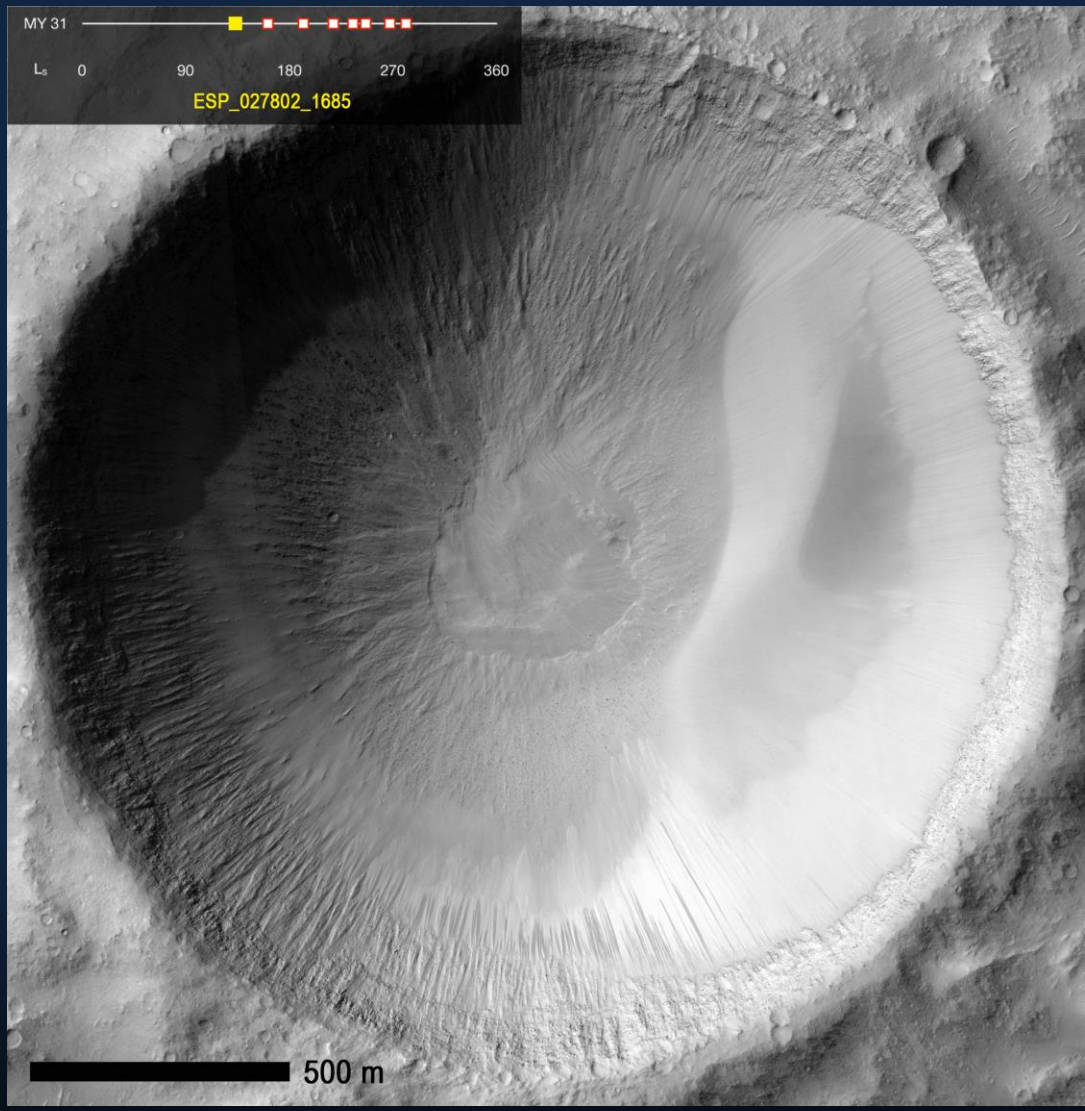
What are RSL?

- Dark flows on steep, low-albedo slopes, typically associated with bedrock and small gullies.
  - Few meters wide, hundreds of meters long.
  - Not found on most steep rocky slopes.
- Recur annually at nearly the same location in multiple Mars years.
- Grow incrementally over a period of several months, then fade.
- Fans have unique spectral properties (Ojha et al. 2013)



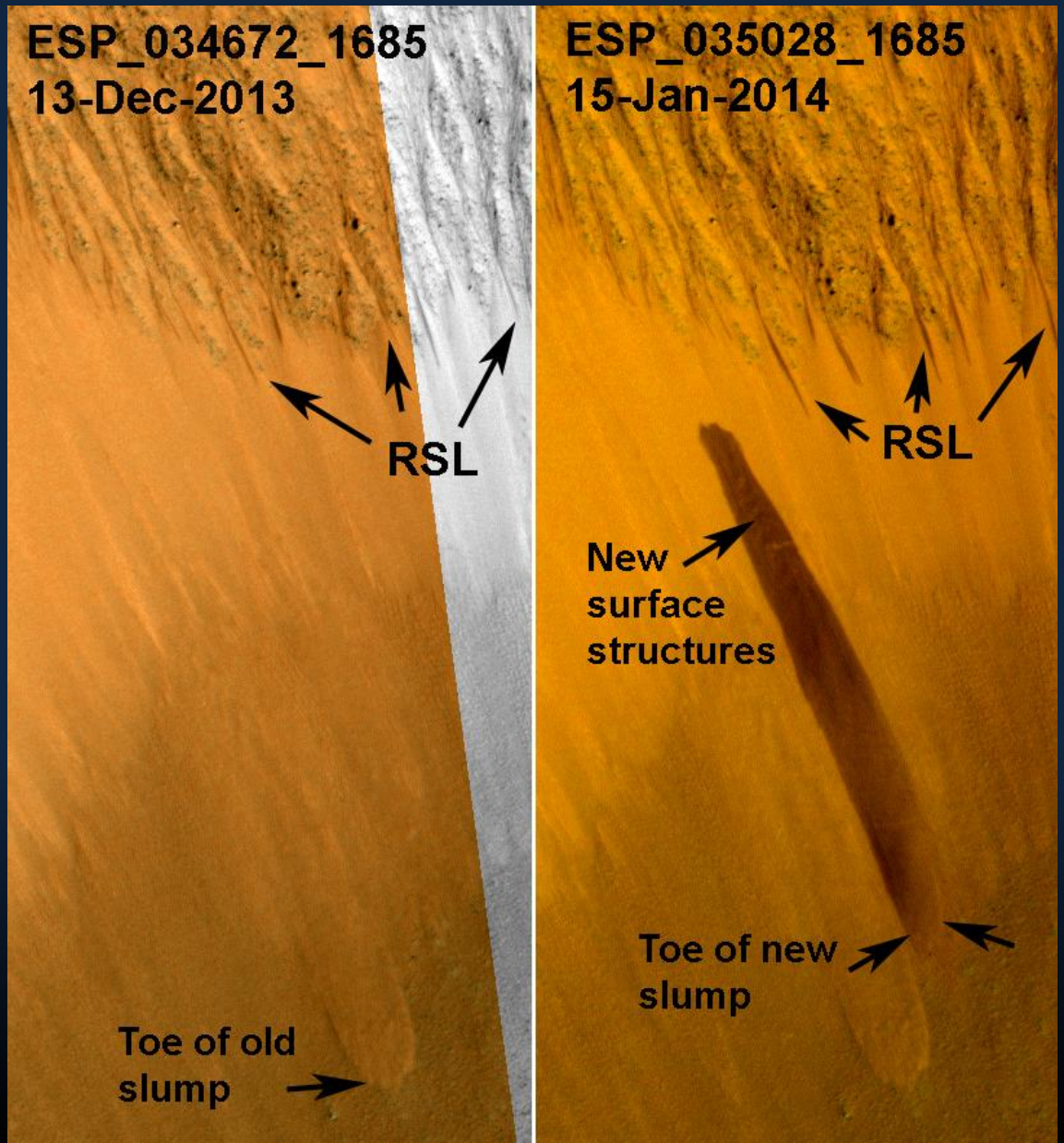
RSL Seasonality

- RSL in the southern mid-latitudes generally grow from late spring through mid-summer.
  - Concentrated on equator-facing slopes.
- RSL in Valles Marineris often follow the sun: growth occurs on south-facing slopes in southern summer and north-facing slopes in northern summer.
- RSL in N hemisphere grow mainly in very early spring (Ls 0)
- Associated with peak diurnal temperatures usually >250 K.
- Strongly suggests that RSL are driven by a volatile. Leading explanation is flow of (salty) liquid water, but source is unknown, and no direct detection of water.

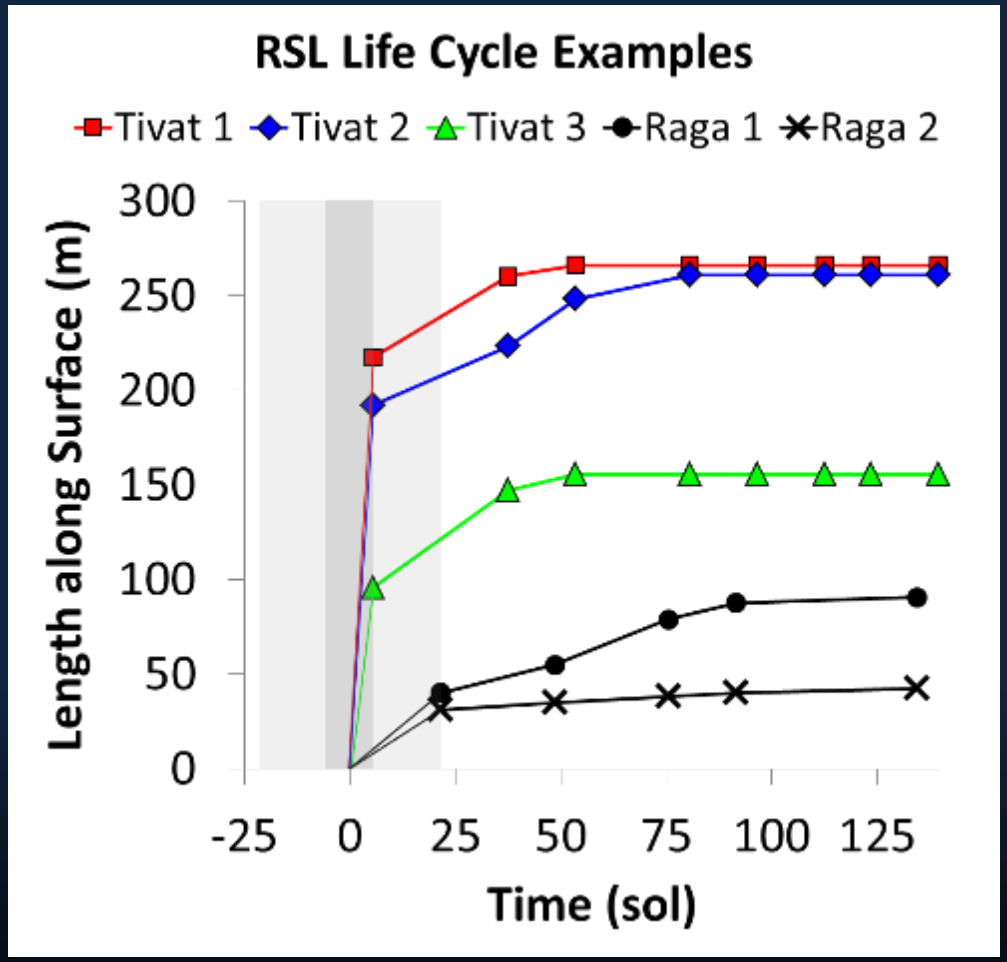


Garni crater on floor of Melas Chasm

Slumping associated with RSL seen in Garni crater and 2 sites in Juventae Chasm



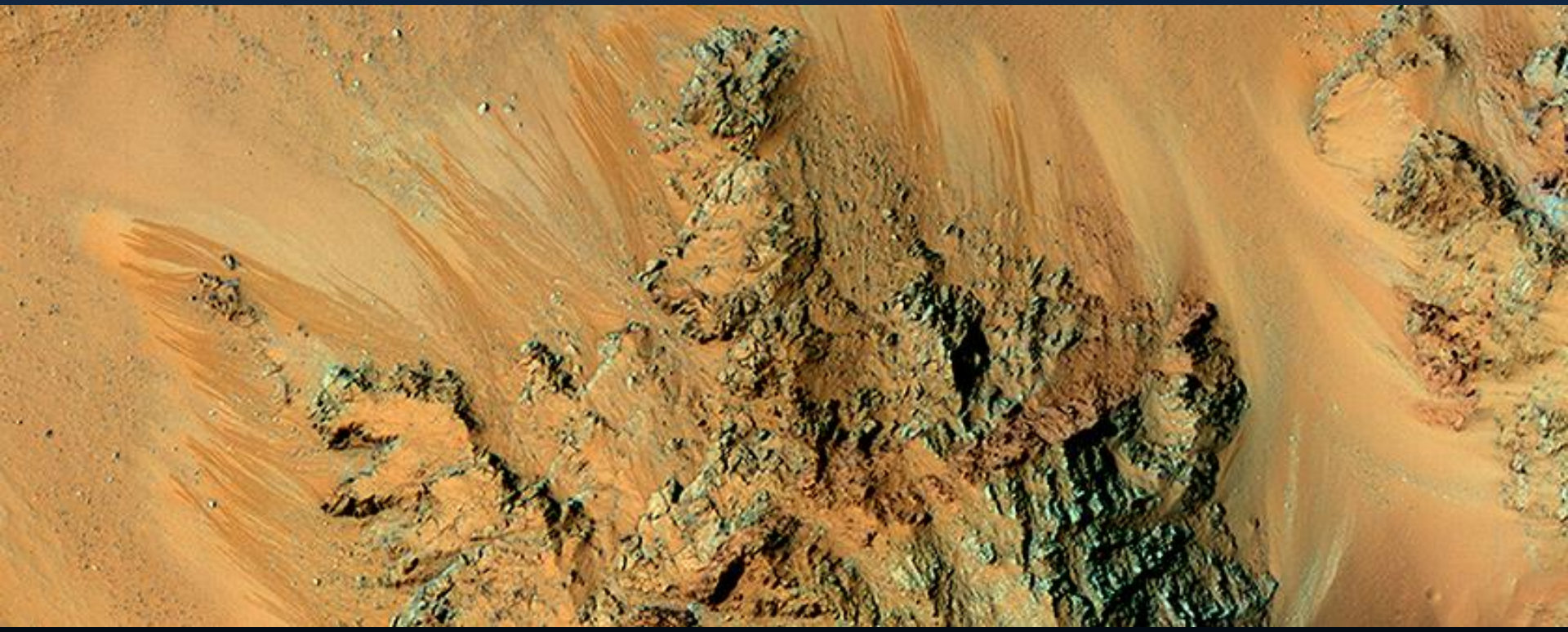
Very Rapid Initial Lengthening Max >20 m/sol



Schaefer et al., 2015, LPSC

Very early (Ls <194) start of RSL activity in Hale crater

- Need to check temperatures, maybe <250 K



Acidalia RSL exactly match from year-to-year. Deliquescence of salts deposited in past years?

Dundas et al., 2015, LPSC

Spectral Evidence for Hydrated Salts in Seasonal Brine Flows on Mars

Nature Geosci, submitted

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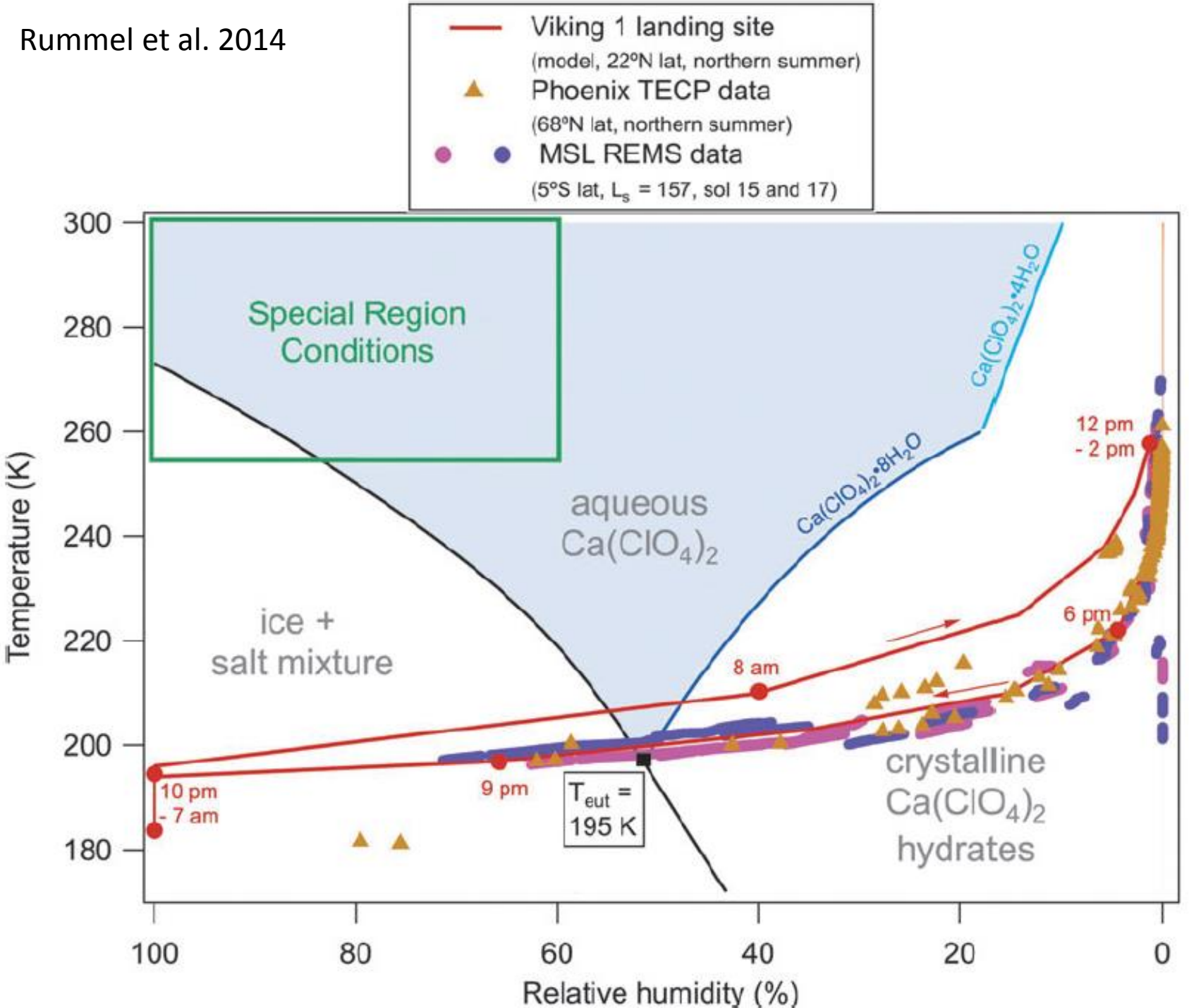
Rummel et al. 2014



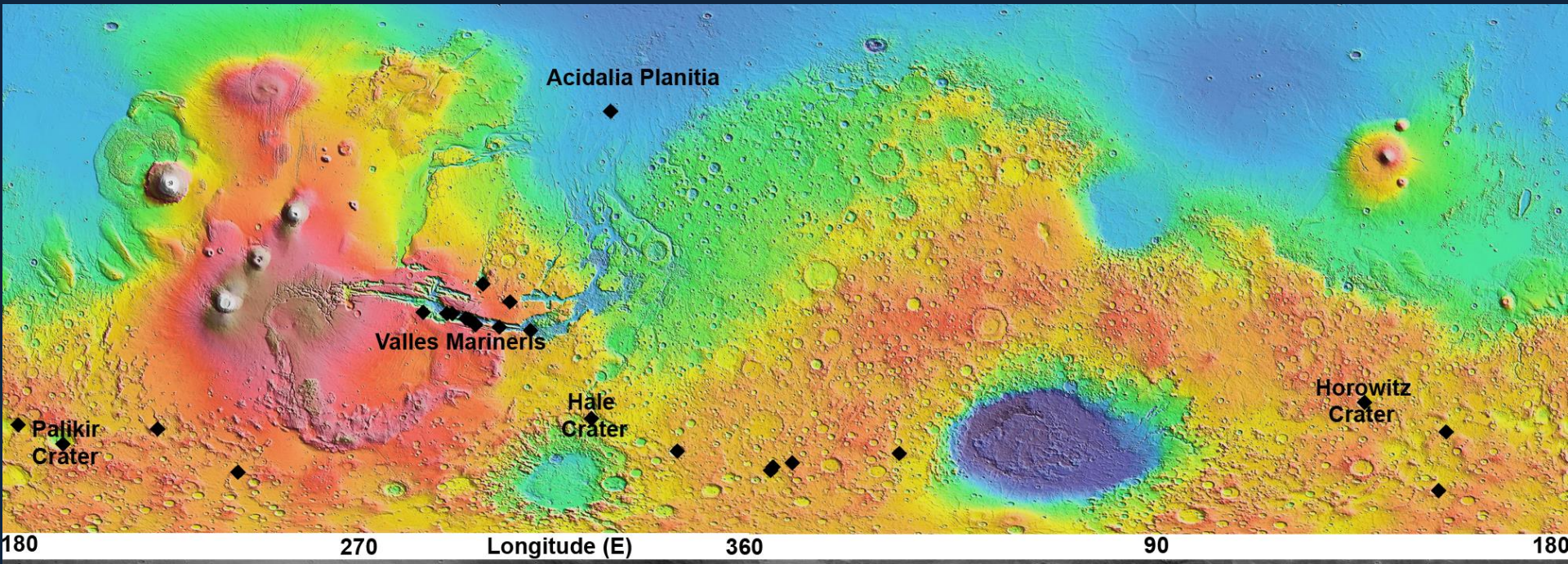
RSL Formation Hypotheses

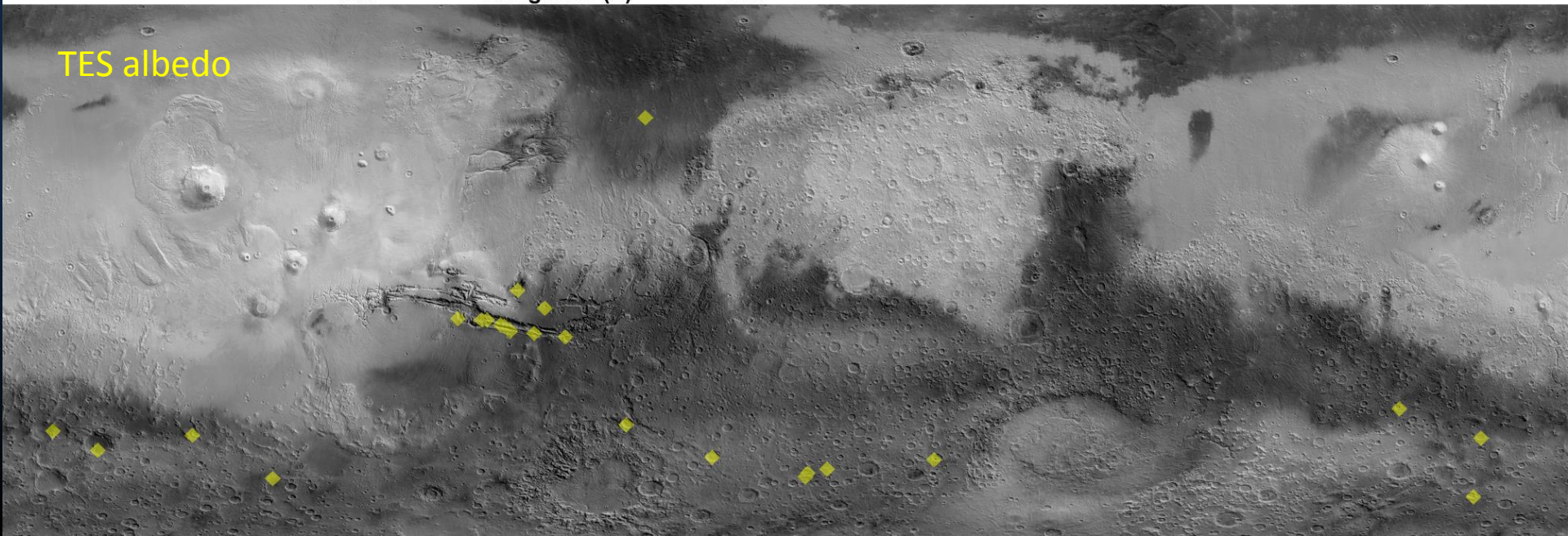
- Dry flows: difficult to explain slow incremental growth on very steep slopes or rapid fading when inactive.
- CO_2 frost-driven: can be excluded because of warm Ts.
  - Likely the driver of gully and polar activity seen at high latitudes.
- Groundwater release:
  - Can be seasonally modulated (Goldspiel and Squyres, 2011).
  - But some RSL start at topographic highs.
- Melting of near-surface ice:
  - Difficult to replenish significant volumes annually.
- Atmospheric source:
  - Not much water in atmosphere
  - Maybe a small amount can trigger dry flows (Masse et al. 2014)
- No hypothesis yet satisfies all observations. All deserve further consideration, and additional constraints are needed.

Evidence for atmospheric influence

- More extensive RSL activity in MY28 after global dust storm
- Darkening fans in Valles Marineris (VM) after summer Acidalia-track dust storms
- RSL extend to tops of ridges and peaks
- RSL over extensive areas, not localized like springs
- Areal darkening associated with RSL—deliquescence?
- Apparent RSL on dunes – too permeable for ground fluids near dune crests
- Acidalia RSL exact copies from year to year
  - Fossil RSL re-darken from deliquescence?
- Spectral evidence for perchlorates
  - Deliquescence must happen when RH and T are in the right ranges
  - But that could be an effect of RSL activity rather than a cause

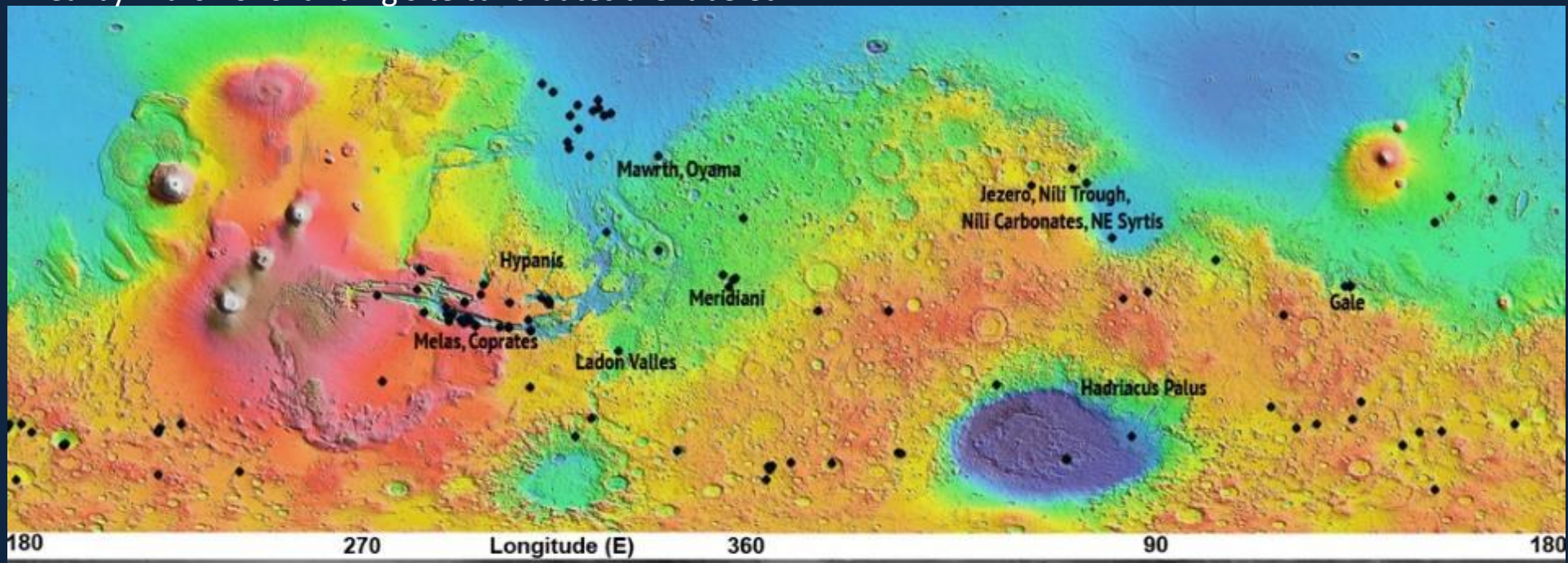
Map of *fully confirmed* RSL sites in 2013
(observed incremental growth, fading, and seasonal recurrence)

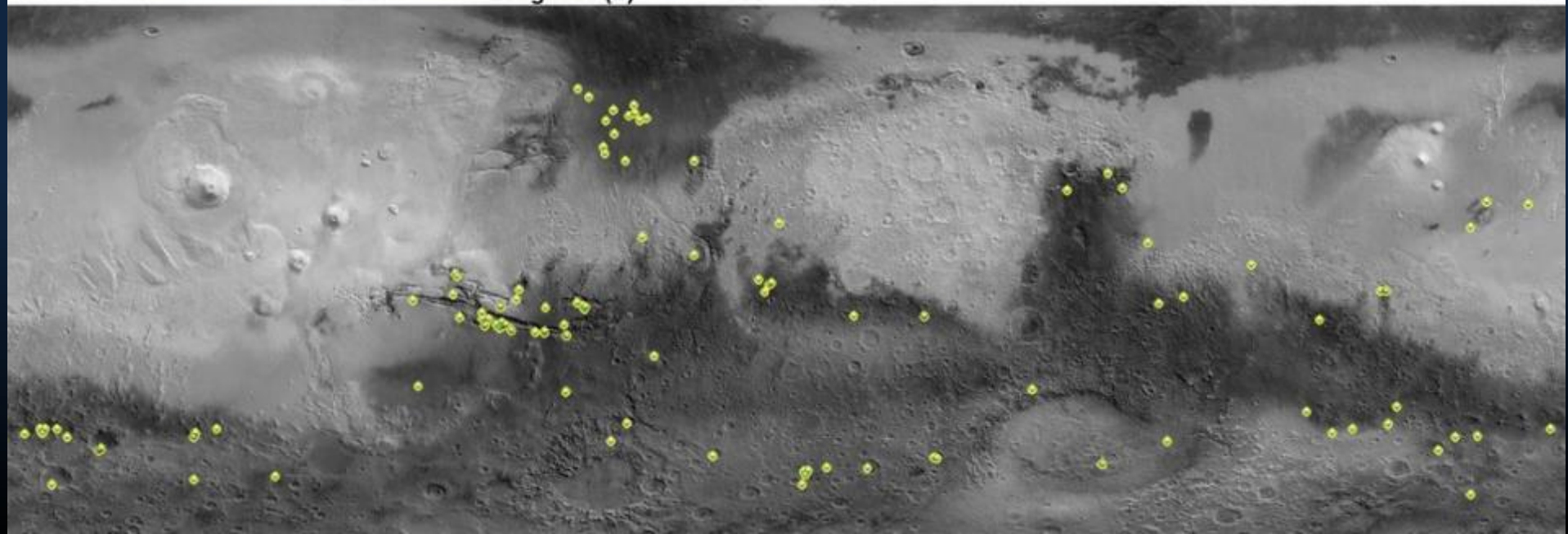




Updated RSL map including candidates (not yet confirmed by repeat imaging).

Nearby Mars 2020 landing site candidates are labeled.





Mars2020 candidate landing sites near potential RSL

- Special Regions SAG (Rummel et al. 2014) defined RSL as potential natural special regions
  - We can't land on steep slopes, but they could be contaminated by off-nominal EDL
- Candidate landing sites affected:
  - Coprates and SW Melas Chasma: many confirmed RSL
  - Meridiani, chloride sites: several craters with confirmed or partially-confirmed RSL
  - Crater just north of Jezero Crater: strong candidate; other weaker candidates in region
    - Many nearby sites: Nili Fossae, Nili Carbonates, Isidis-Syrtis
  - Mawrth Vallis, Oyama Crater, McLaughlin crater, and Ladon Valles have weak candidates
  - Other sites: none identified yet, but
    - Existing images not thoroughly searched, may have been acquired when RSL were faded, and cover a small fraction of the regions
- NASA needs to define a policy about landing site candidates near confirmed or candidate RSL sites

Implications

- Mars 2020 cannot land or drive on the very steep slopes with RSL
  - Cannot directly contact or contaminate these potential special regions
  - Planetary Protection concern only for potential off-nominal EDL
- Mars 2020 can acquire valuable new knowledge about RSL
  - Can image through all times of day, so wetting and drying soil should be obvious. MRO can only observe near 3 PM, the driest time of day.
  - If rover can get close enough for SuperCam to acquire compositional data, that would be extremely valuable
  - MEDA data near RSL site would be very valuable to understand origin of water
- Understanding RSL may be key to future human exploration
  - They need water to survive, and equatorial landing sites are best for thermal management
    - No known shallow ice in equatorial regions, so RSL are best candidate indicators of water
    - If origin of RSL water is atmospheric, do these sites show where it is easiest to extract water from the atmosphere?
    - If RSL water is from the subsurface, then habitability is more favorable
- In conclusion, Mars 2020 landing near an RSL site would be most excellent for Mars science and future exploration