Should the RSL be an astrobiology priority?

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Case for biology?

Case for water?

Case for activity?
Recurring Slope Lineae (RSL) are active

**RSL:** Rare, warm-season annually-repeating flows on low-to-midlatitude Martian slopes.

McEwen et al., *Science* 2011 / HiRISE ‘Science in motion’

Ojha et al., this workshop

32°S / Ls 334

Central peak of Horowitz crater
RSL in context: if wet, RSL are isolated anomalies

Unlikely that RSL are tapping regional/global aquifers
No hotspots/springs (THEMIS); no clear evidence of outgassing; low mantle heat flow (flexure); evidence for recent outburst floods is questionable (HiRISE); no(?) present-day deep aquifers (MARSIS); little VNIR evidence for recent non-transient H$_2$O(l) (CRISM); no melt at base of ice sheets (SHARAD); Long term $T_{avg} \sim T_{now}$ (ice creep)

Active layers / interfacial water possible.
Recent H$_2$O(l) at equator? Troy deposit; Slope streaks in dusty regions do not require H$_2$O(l); RSLs (McEwen et al., Science 2011); H$_2$O(l) not involved in modern gully activity; Geomorphology suggests active layers (but spatially restricted); Phoenix did not find organic matter; Insulating regolith at low pressure (?) (Wood et al.); Dark Dune Spots? / Interfacial water (e.g. Möhlmann et al., Icarus 2011)
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RSL are active, but if wet, they are isolated
Atmospheric water source?

**Summer melt of winter snow?** Survival of surface H$_2$O(i) into warm season in Valles Marineris is challenging (6 mbar)

**Salt deliquescence?**  
\[ Q = V C_E W \]
\[ V = 10 \text{ m/s}, \ C_E = 3 \times 10^{-3}, \ W = 3 \times 10^{-5} \text{ kg/m}^3 \]
\[ \rightarrow \sim 0.1 \text{ kg/m}^2/\text{sol} \]

Test: Time of day

Möhlmann et al., P&SS, 2009
Are RSL sustainable? Water and salt budgets

Mars: RSL mechanisms require salt (>20% of water) – demand outpaces atmospheric resupply – **salt supply is a major problem for (wet) RSL sustainability**

Antarctica: salt from sea-spray, snowfall

- Levy et al., GSA 2011; Chevrier et al., GRL 2012; Gough et al., EPSL, 2011; Davila et al., Astrobio. 2010; McEwen et al., Science 2011; Hanley et al., GRL, 2012; Marion et al., Icarus 2010; Robertson & Bish, JGR 2011.
Bedrock water source: How can RSL be sustained?

- Dehydration/incongruent melting
- Meltwater, locally enhanced $[\text{H}_2\text{O}_{(v)}]$
- Hydrated evaporite layer
- $U \sim 1-10$ mm/yr
- $\kappa/U \sim 5$ m

Slow dehydration kinetics, e.g.:  
Wang et al., JGR, 2009  
Wang et al.,  
Xu et al., Am. Min., 2009  
Chou & Seal., JGR, 2007  
Chipera & Vaniman, GCA, 2007
Bedrock water source: How can RSL be sustained?

Tests:
- Geomorphic/age differences between RSL-bearing slopes and RSL-free slopes
- 5 year COSICorr baseline → 2.5 mm/yr
- Viscosity?

Bedrock disaggregation:
Balboni et al., Environ. Earth Sci., 2010

Slow dehydration kinetics:
- Wang et al., JGR, 2009 (&c.)
- Xu et al., Am. Min., 2009
- Chou & Seal., JGR, 2007
- Chipera & Vaniman, GCA, 2007

Geomorphology:
- Meltwater, locally enhanced \([H_2O_{(v)}]\)
- Dehydration/incongruent melting
- Hydrated evaporite layer: \(U \sim 1-10\) mm/yr
- Talus removal by wind

Notes:
- Bedrock disaggregation: Balboni et al., Environ. Earth Sci., 2010
- Slow dehydration kinetics:
  - Wang et al., JGR, 2009 (&c.)
  - Xu et al., Am. Min., 2009
  - Chou & Seal., JGR, 2007
  - Chipera & Vaniman, GCA, 2007
If wet, RSL are **transient** features (?)

- salt budget (this talk)
- water budget (Stillman et al., this workshop)
- ‘recharge mechanism’ (Chevrier & Rivera-Valentin, GRL, 2012)
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Salt and water mass balance demands that RSLs are transient (if wet)

RSL are active, but if wet, they are isolated
External reservoir of biological material is needed to seed RSL: dust, soil, or evaporitic bedrock

Thought experiment: RSL in sealed box

Pasteur’s experiment: *Cockell, this workshop*
To justify the additional expense of going to the RSL, the science case for prioritizing the RSL should say:

1. Mars has a background level of biological material in globally distributed reservoirs (dust, soil, or evaporitic bedrock) but this is below detection level with current/planned instruments.

2. The RSL microenvironment permits microbial reproduction and this will amplify the level of biological material above threshold with current/foreseeable instruments.

   e.g., Fletcher et al., Ad.Sp.Res. 2012
• RSL are **isolated**

• If RSL are wet, then RSL are **transient**

• Justifying the additional expense of going to RSL for astrobiology is **difficult**
  
  – Need biological material in background reservoirs for inoculation;

  – But if too abundant/widespread, the need to go to RSLs evaporates.
Supplementary slides
THE MOUNTAINEER’S ROUTE IS NOT EASY

• Colonization timescale ↔ lifetime of RSL ↔ detectability in ‘background materials’

Calculate amplification factor; energy, UV tradeoffs, nutrients, N(?) delivery, # doubling events/wet season; thermodynamic limits.

+ve: Readily satisfy planetary protection constraints
-ve: ?