TARGETING HABITABLE 
SUBSURFACE ENVIRONMENTS 
WITH MARS 2020

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SEDIMENTARY
-OR-
“SURFACE”

HYDROTHERMAL
-OR-
“SUBURFACE”
The Big Picture

By 3.5 Ga, Mars was probably mostly hyperarid, cold, acidic, bathed in UV and generally a bummer.

Michalski et al., Nature Geoscience, 2013
DEEP BIOSPHERE

FACTORS TO CONSIDER

HOW DO THESE FACTORS RELATE TO THE MARTIAN ENVIRONMENT?

- CARBON, NITROGEN FOR BIOMASS
- NUTRIENTS (C,H,O,N,P,S) TO SUPPORT LIFE
- ENERGY SOURCES
- POROSITY
- AQUEOUS FLUIDS
THE MARTIAN SUBSURFACE

Michalski et al., Nature Geoscience, 2013
EXAMPLE OF EXHUMED MATERIALS IN LEIGHTON CRATER, MARS

Michalski and Niles., Nature Geoscience, 2010
DEEP CRUSTAL CLAYS AND CARBONATES OBSERVED THROUGH REMOTE SENSING

Michalski and Niles., Nature Geoscience, 2010
FAULTED, FOLDED, FRACTURED AND FOLIATED

Michalski and Niles., Nature Geoscience, 2010
Excellent target for future exploration
-would likely teach us about prebiotic chemical processes,
CANDIDATE LANDING SITE

<table>
<thead>
<tr>
<th>Context</th>
<th>Image Description</th>
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<tbody>
<tr>
<td><strong>CTX/HiRISE</strong></td>
<td>Image of a candidate landing site showing a circular area highlighted.</td>
</tr>
<tr>
<td><strong>CTX/CRISM BD2540</strong></td>
<td>Similar to <strong>CTX/HiRISE</strong>, with additional color mapping.</td>
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<tr>
<td><strong>MOLA</strong></td>
<td>A different perspective, possibly a topographical view with color differentiation.</td>
</tr>
<tr>
<td><strong>THEMIS Nighttime IR</strong></td>
<td>Color representation emphasizing nighttime infrared imaging.</td>
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The images collectively highlight different aspects of the candidate landing site, including context, thermal analysis, topography, and color mapping for a comprehensive view.
ISSUES WITH CATEGORY 1 SITES (EXHUMED CRUST)

- **Would these environments have high cell densities in the deep crust?**
- **Shock pressures and temperatures could “impact” preservation potential**
- **Are the biosignatures detectable with a Mars rover-type payload?**

*Testable!*
A DEEP MARTIAN BIOSPHERE?

Michalski et al., Nature Geoscience, 2013
McLaughlin Crater

- Channels in wall, terminate ~500 m above the floor
- Ejecta from Keren on floor
- Lobate materials
- Layered sed rx

Michalski et al., Nature Geoscience, 2013
LAYERED SEDIMENTS AND LOBATE MATERIALS
MORPHOLOGY OF DEBRIS FLOW

flow front

clays + carbonates

100 m

N

500 m
Layered units on the crater floor

clay-carbonate layers

100 m
EVIDENCE FOR ALTERATION BELOW A BASE LEVEL?
CANDIDATE LANDING ELLIPSE
CANDIDATE LANDING ELLIPSE
McLaughlin Crater Summary

- Evidence for lacustrine setting
- Alkaline, saline, Mg-Ca-Fe-rich fluids
- Sedimentary rocks/hydrothermally driven activity?
UPWELLING SHOULD OCCUR FIRST IN DEEP BASINS

McLaughlin might be the best candidate for upwelling on Mars
ALKALINE LAKE IN LONAR CRATER

PH = ~10, SALINITY 10%, HIGH CALCIUM-MAGNESIUM
McLaughlin Crater: Conclusions

• Mineralogy and geomorphology suggestive of lacustrine setting
• Possibly hydrothermal/driven by groundwater
• Land-on science
• Low elevation (-5000 m)
• Connection to a regional cap unit
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