Environmental Signatures for Habitability: What to Measure and How to Rank the Habitability Potential of Mars

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<table>
<thead>
<tr>
<th>CHEMICAL</th>
<th>PHYSICAL</th>
<th>MORPHOLOGICAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elements</td>
<td>Temperature</td>
<td>Large scale process indicators (volcanism, seismicity, impact &amp; rebound, etc)</td>
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<tr>
<td>Inorganic compounds</td>
<td>Radiation (eg, cosmic, radionuclide decay)</td>
<td>Sedimentary structures</td>
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<tr>
<td>Water (abundance &amp; state)</td>
<td>Solar radiation (λ and intensity)</td>
<td>Finer scale textures</td>
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<tr>
<td>Organic chemicals</td>
<td>Mass</td>
<td>Mechanical stability</td>
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<tr>
<td>Phase state volatiles</td>
<td>Wind speed, direction &amp; variability</td>
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<td></td>
<td>Humidity</td>
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<tr>
<td>Redox</td>
<td>Dynamics</td>
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Candidate MSL Landing Sites

**Holden crater:**
bedrock outcrops, alluvial fans, rich history of aqueous processing

**Eberswalde crater:**
well defined delta suggests long duration water flow

**Mawrth:** strong CRISM and OMEGA signatures of Fe/Mg and Al phyllosilicates – may be good preservation environment for organics

**Gale crater:** diversity of mineralogy in well defined layered sequences that could be traversed by MSL
General Approach on Earth and Mars

1. First, study remote sensing data, maps, etc.
2. Decide how big an area to measure.
   - Science driven
   - Technology, safety, finance and time constrained
3. Determine the spatial sampling rate.
   - Science driven
   - Technology, finance and time constrained
4. Determine the temporal sampling rate.
   - Science driven
   - Technology, safety, finance and time constrained
5. Determine the order of measurements
   - Primarily technology constrained, but also by safety and time
6. Decide where to begin measurements
7. Randomly select locations and proceed (not on Mars)
What to Use on MSL

**Structural & Morphological Signatures**

- MASTCAM
- MAHLI
- CHEMCAm (RMI)
- CHEMIN
What to Use on MSL

Chemical Signatures

- MASTCAM
- DAN
- CHEMCAM (LIBS)
- APXS
- CHEMIN
- SAM
What to Use on MSL

Physical Signatures
REMS
RAD
MASTCAM
CHEM CAM
<table>
<thead>
<tr>
<th>CLASS</th>
<th>CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLASS ONE</td>
<td>Uninhabitable and likely has never been habitable</td>
</tr>
<tr>
<td>CLASS TWO</td>
<td>Has a high potential but no confirmed observation of life (as defined above)</td>
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<tr>
<td>CLASS THREE</td>
<td>Inhabited (we find life)</td>
</tr>
<tr>
<td>A</td>
<td>Globally inhabited</td>
</tr>
<tr>
<td>B</td>
<td>Primitive life; early in its evolution, but not yet globally established</td>
</tr>
<tr>
<td>C</td>
<td>Exists only in refugia—planet heading toward class four</td>
</tr>
<tr>
<td>CLASS FOUR</td>
<td>Post-habitable (there once was life, but now it’s gone)</td>
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