Introduction: Overview of the MSL Landing Site at Mawrth Vallis

MANY PERSPECTIVES
INTERNATIONAL COLLABORATION
MULTIPLE WORKING HYPOTHESES
MAWRTH VALLIS FOR MSL: KEY POINTS, UNIQUE CHARACTERISTICS

- **Mineralogically diverse** site, both in the ellipse and in the region
- **Lithologically diverse** site that captures multiple environments
- **Both** in-situ, ancient crustal bedrock and remobilized sediments
- **Many** types of science **targets**
- Extremely **ancient section** of rocks probing an enigmatic and important epoch in Solar System history
- Opportunity to **sample rocks** from the deep Noachian up through the global transition into the Hesperian
GEOGRAPHIC CONTEXT
MINERALOGICAL DIVERSITY: CHEMICAL GRADIENTS?

- Follow the minerals:
  - Fe/Mg-smectites
  - Al-smectite
  - Kaolinite
  - Opaline silica
  - Fe2+ hydrated phase
  - Sulfates
  - Other hydrated phases

- Diverse mineralogy indicates that we have multiple environments in which to:
  - Search for biomarkers
  - Build a more complete picture of habitable environments at Mars

*Bishop et al., Science, 2008*
Why type of rocks do the clays occur within?

Cannot be just one lithology because of the wide range of geomorphology-lithology inferred from images.
GEOMORPHOLOGY OVERVIEW

- Layers everywhere
- Many expressions of layered units
- Erosion and redeposition by fluvial and eolian activity
GEOMORPHOLOGY AND LITHOLOGY OF THE CLAY-BEARING ROCKS

- There are a number of geomorphic expressions that indicate a range of lithologies

Michalski and Noe Dobrea, *Geology*, 2007
MULTIPLE SCIENCE TARGETS

- Hedge our bets by visiting multiple targets, each with intrinsic merit
TRAVERSING MARS’ AQUEOUS HISTORY

- Ancient, in-situ bedrock
- Younger, reworked, clay-bearing rocks
- Sulfate-bearing rocks
- Hesperian, dark cap unit
WHY DO WE SEE SPECIAL GEOLOGY AT MAWRTH VALLIS?

- Localized environment?
  - Or
- Unusual erosion of the region?

- Connection to the global picture
## TESTABLE HYPOTHESES

### Key observables:

#### Source of sediment

<table>
<thead>
<tr>
<th>Volcanic Model</th>
<th>Sedimentary Model</th>
<th>Pedogenic Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash fall</td>
<td>Ash flow</td>
<td>same as above, overprinted on any of the above</td>
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<table>
<thead>
<tr>
<th>Texture and bedding</th>
<th>Composition</th>
<th>Geologic contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>angular glass shards (MAHLI, CheMin), laminated bedding (MastCam, MAHLI)</td>
<td>Mineralogy dominated by glass and secondary phases (APXS, CheMin, ChemCam)</td>
<td>Depositional contact, if in lacustrine system, unconformable contact if on land (MastCam, MAHLI, ChemCam, CheMin, APXS)</td>
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<tr>
<td>angular glass shards (MAHLI, CheMin), cross bedding related to surge (MastCam, MAHLI)</td>
<td>Mineralogy dominated by glass and secondary phases (APXS, CheMin, ChemCam)</td>
<td>Depositional contact, if in lacustrine system, unconformable contact if on land (MastCam, MAHLI, ChemCam, CheMin, APXS)</td>
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<tr>
<td>very fine grained textures (MAHLI), uniquely dust or aggregates of dust</td>
<td>Mineralogy may be dominated by secondary phases, could contain evidence for primary feldspar and pyroxene (CheMin, APXS, ChemCam)</td>
<td>Depositional; composition probably cuts bedding because water source is likely groundwater from ice melt (APXS, ChemCam, MastCam, MAHLI, CheMin)</td>
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<tr>
<td>rounded sand grains in cross bedded rocks (MastCam, MAHLI) primary oxides (CheMin, APXS, ChemCam)</td>
<td>Abundant primary feldspar, possibly primary oxides (CheMin, APXS, ChemCam)</td>
<td>Depositional, composition follows bedding (APXS, ChemCam, MastCam, MAHLI, CheMin)</td>
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<tr>
<td>rounded sand grains interbedded with silt-dominated deposits, coarsening upward sequence(s) (MastCam, MAHLI)</td>
<td>Abundant primary feldspar, possibly primary oxides (CheMin, APXS, ChemCam)</td>
<td>Depositional, composition follows bedding (APXS, ChemCam, MastCam, MAHLI, CheMin)</td>
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<td>fragmented, angular clasts spanning a range of grain sizes; impact glass (MastCam, MAHLI, CheMin)</td>
<td>Basaltic primary minerals (CheMin), meteoritic elements (CheMin, APXS, ChemCam)</td>
<td>Series of unconformable contacts, composition probably does not follow bedding because source of water is likely to be groundwater (APXS, ChemCam, MastCam, MAHLI, CheMin)</td>
</tr>
<tr>
<td>Could be overprinted on any of the above, but may also contain vugs, various &quot;soil&quot; structures, evidence for impact gardening</td>
<td>Could be overprinted on any of the above, but may also contain higher values of immobile elements and oxide minerals in pedogenic horizons (CheMin, APXS, ChemCam)</td>
<td>Pedogenic horizons should contain disrupted lower contacts, composition should not uniquely follow primary bedding (CheMin, APXS, ChemCam)</td>
</tr>
</tbody>
</table>
BIBLIOGRAPHY

14 Peer reviewed (perhaps we suffer a bit from too much information)


- Sumner, D (submitted). Physical outcrop characteristics of the Mawrth MSL candidate landing site. IJMSE.