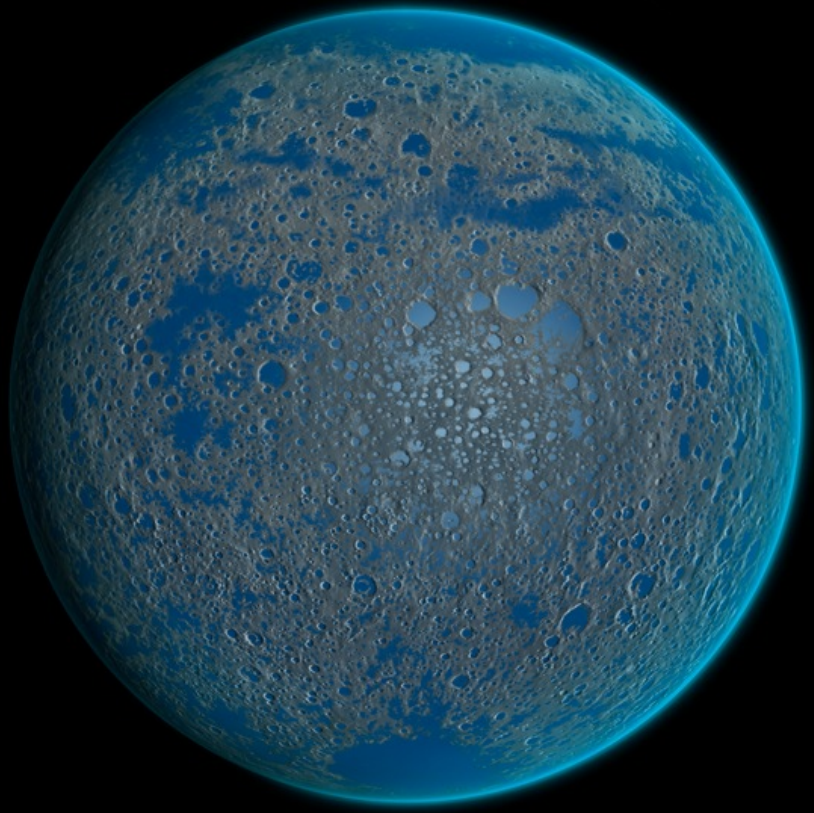
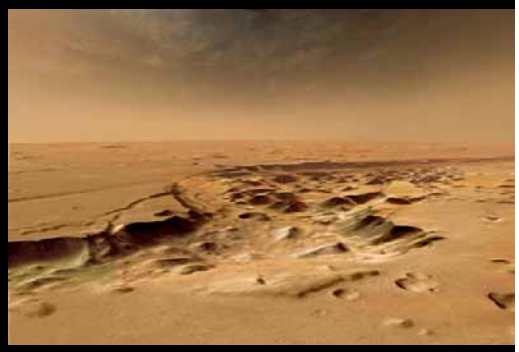
Mawrth Vallis

preserving the origins

Introduction: Overview of the MSL Landing Site at Mawrth Vallis





J. Michalski, J-P. Bibring, J. Bishop, J. Carter, B. Ehlmann, D. Loizeau, N. Mangold, N. McKeown, J. Mustard, E. Noe Dobrea, M. Parente, F. Poulet, J. Wray

MANY PERSPECTIVES
INTERNATIONAL COLLABORATION
MULTIPLE WORKING HYPOTHESES

Phyllosilicate Diversity and Past Aqueous Activity Revealed at Mawrth Vallis, Mars

Evidence for a sedimentary origin of clay minerals in the Mawrth Vallis region, Mars

Characterization of phyllosilicates observed in the central Mawrth Vallis region, Mars, their potential formational processes, and implications for past climate

ARTICLES

Phyllosilicates on Mars and implications for early martian climate

Compositional stratigraphy of clay-bearing layered deposits at Mawrth Vallis, Mars

Identification of the Ca-sulfate bassanite in Mawrth Vallis, Mars

LETTERS

Hydrated silicate minerals on Mars observed by the Mars Reconnaissance Orbiter CRISM instrument

RESEARCH ARTICLE

Mars Surface Diversity as Revealed by the OMEGA/Mars Express Observations

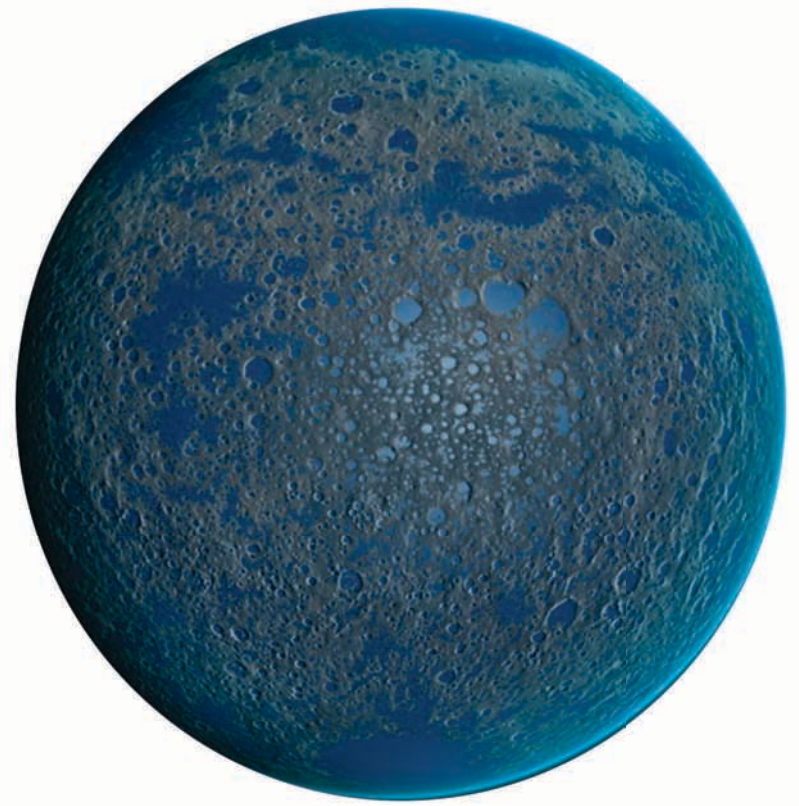
RESEARCH ARTICLES

Global Mineralogical and Aqueous Mars History Derived from OMEGA/Mars Express Data

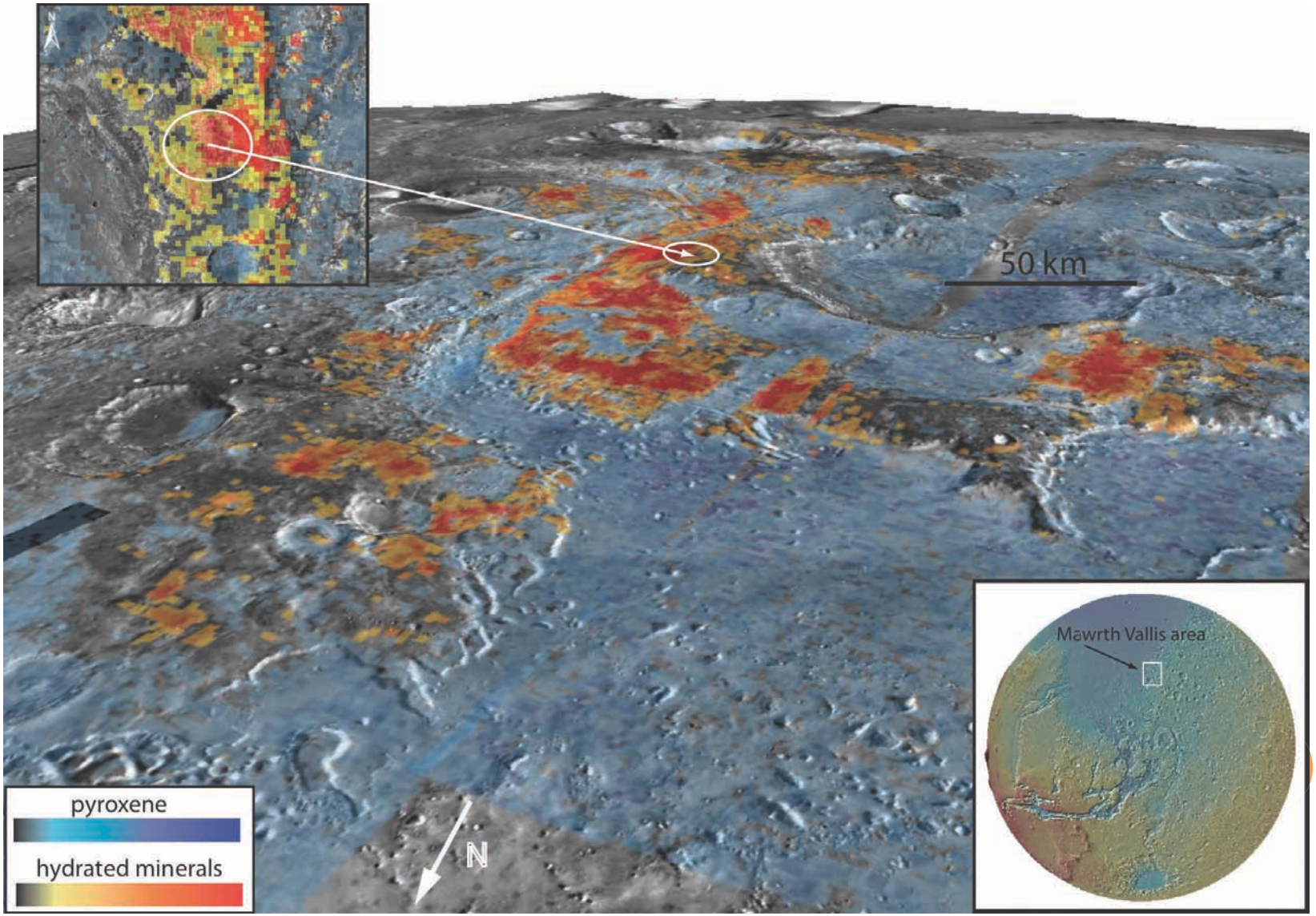
Phyllosilicates in the Mawrth Vallis region of Mars

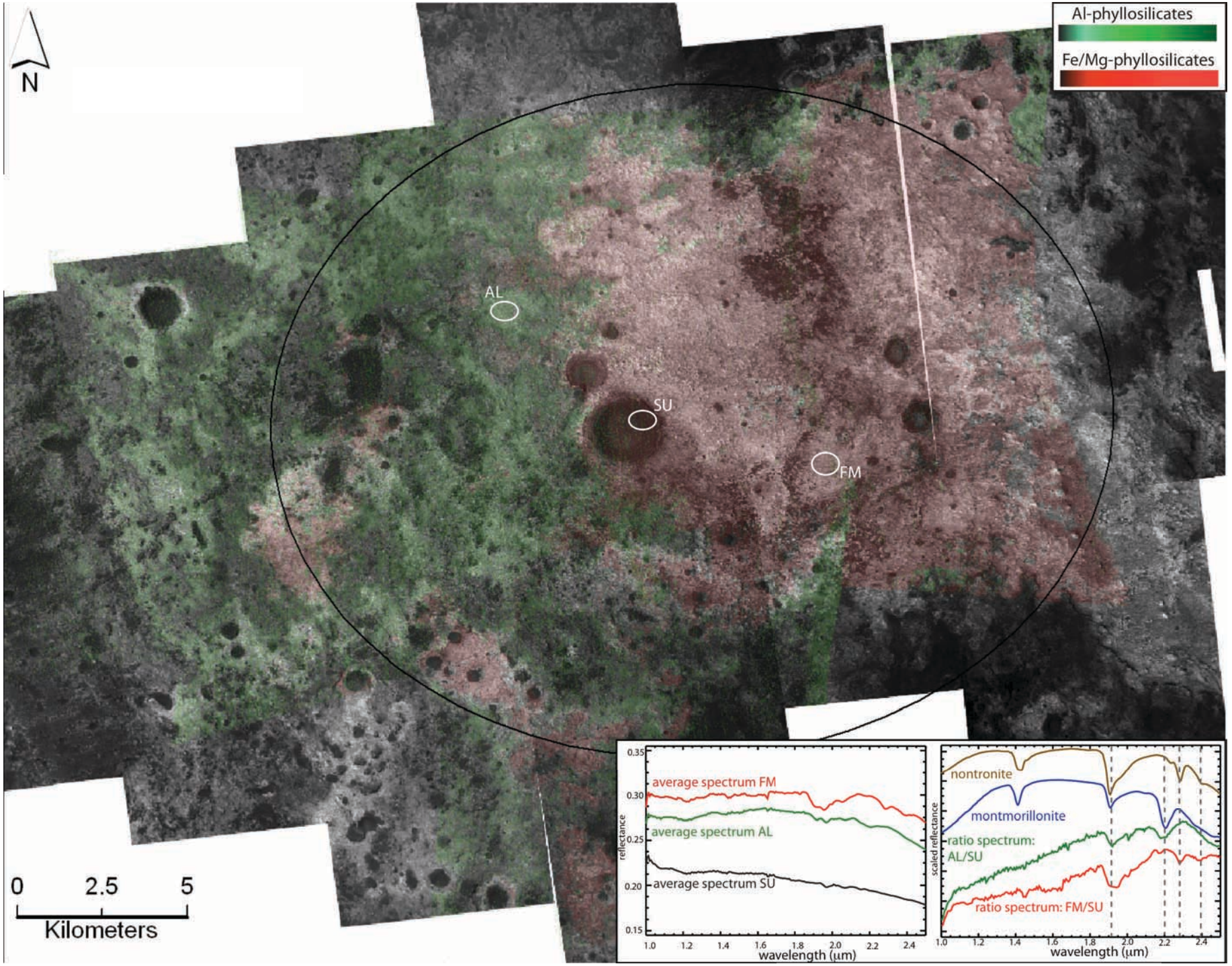
MAWRTH VALLIS FOR MSL: KEY POINTS, UNIQUE CHARACTERISTICS

- **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



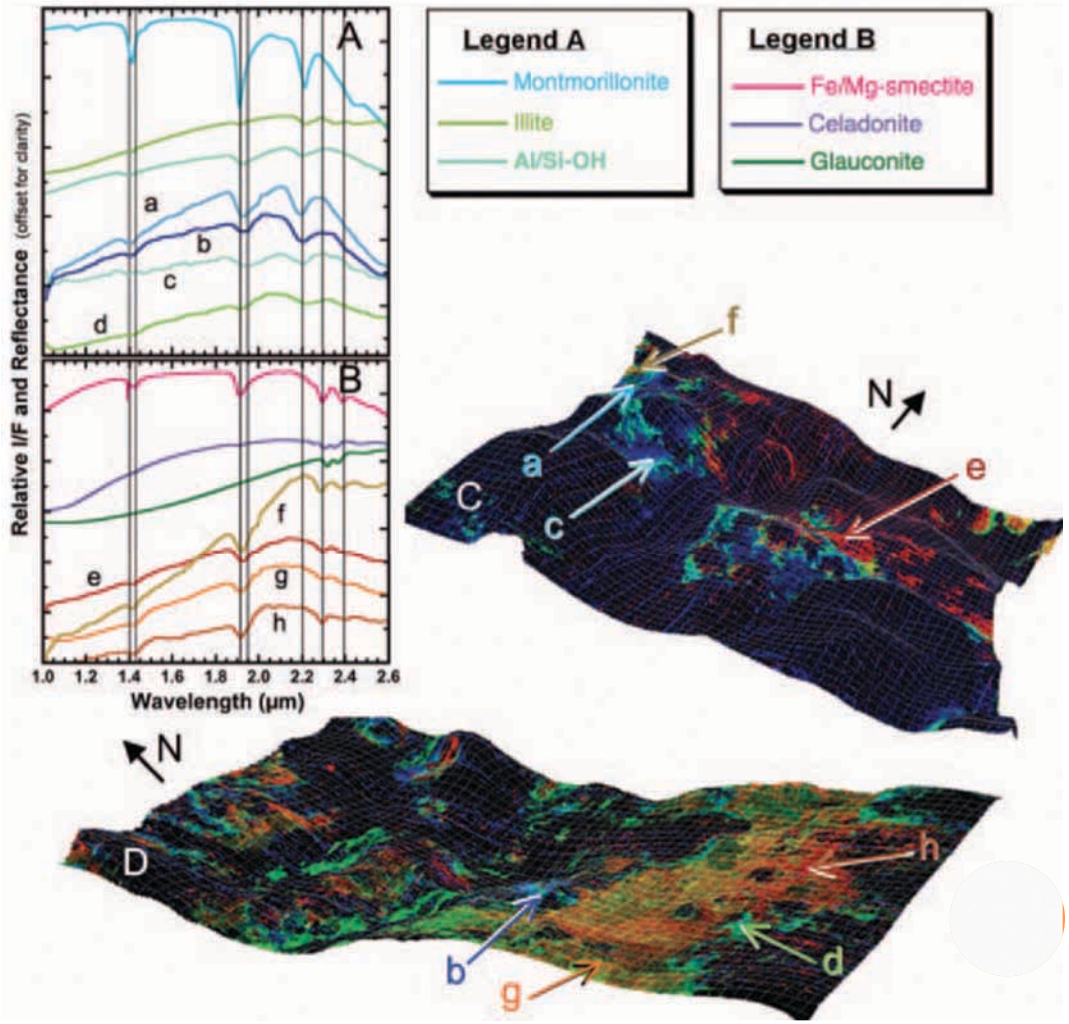
GEOGRAPHIC CONTEXT




N
Al-phyllosilicates
Fe/Mg-phyllosilicates
AL
SU
FM
0
2.5
5
Kilometers
average spectrum FM
average spectrum AL
average spectrum SU
reflectance
wavelength (μm)
nontronite
montmorillonite
ratio spectrum: AL/SU
ratio spectrum: FM/SU
scaled reflectance
wavelength (μm)

MINERALOGICAL DIVERSITY: CHEMICAL GRADIENTS?

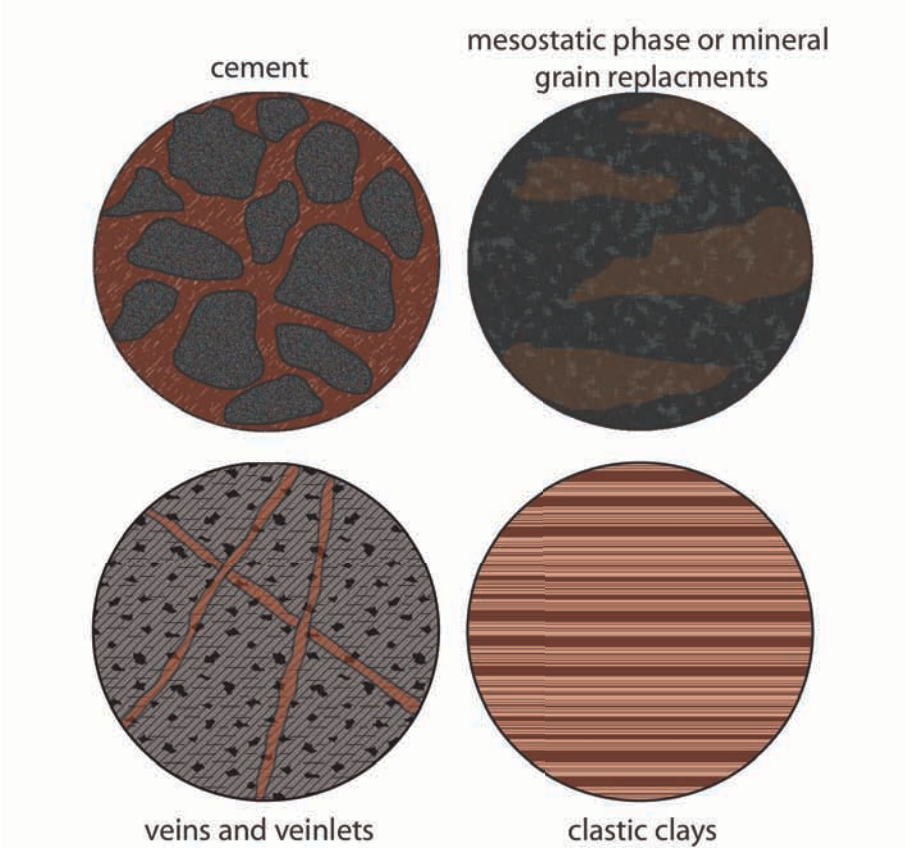
- Follow the minerals:
  - Fe/Mg-smectites
  - Al-smectite
  - Kaolinite
  - Opaline silica
  - Fe2+ hydrated phase
  - Sulfates
  - Other hydrated phases
- Diverse mineralogy indicates that we have multiple environments in which to:
  - Search for biomarkers
  - Build a more complete picture of habitable environments at Mars



Bishop et al., Science, 2008

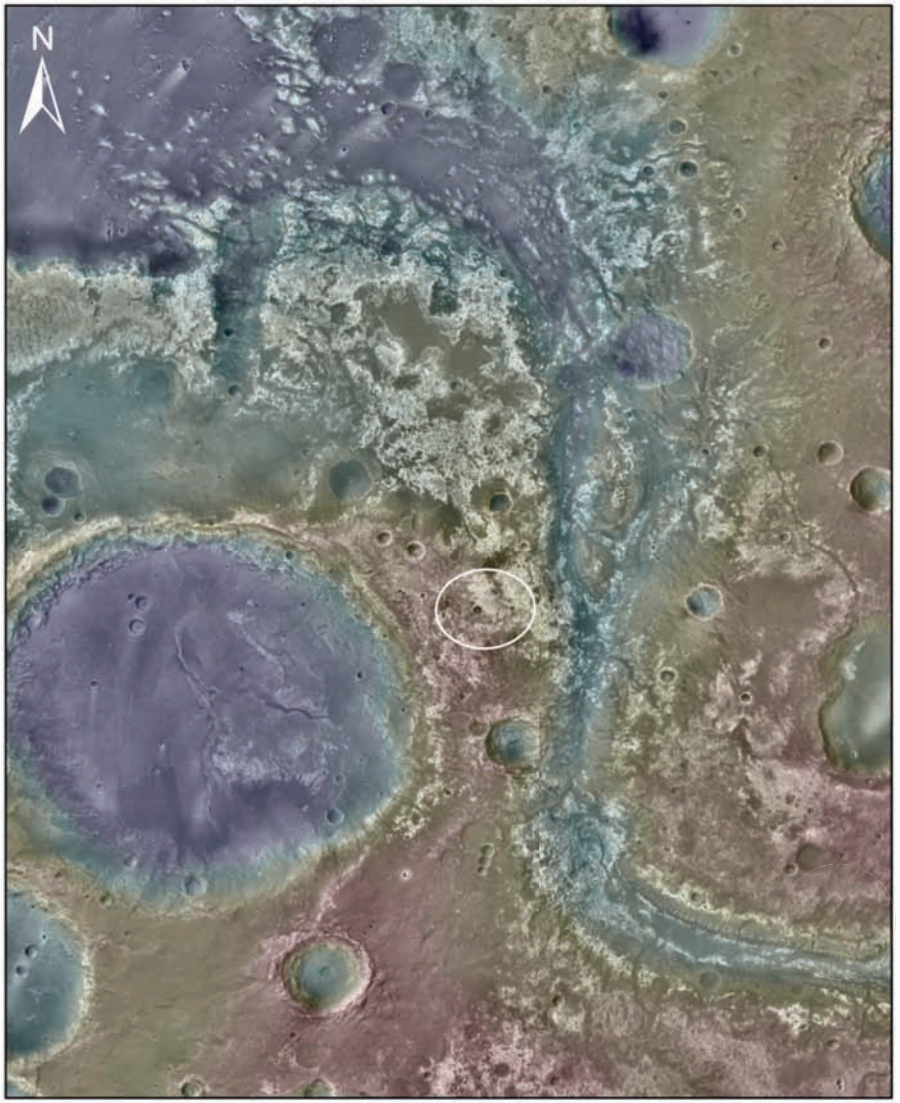
LITHOLOGIC CONTEXT OF MINERALS DETECTED BY INFRARED OBSERVATIONS

- 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

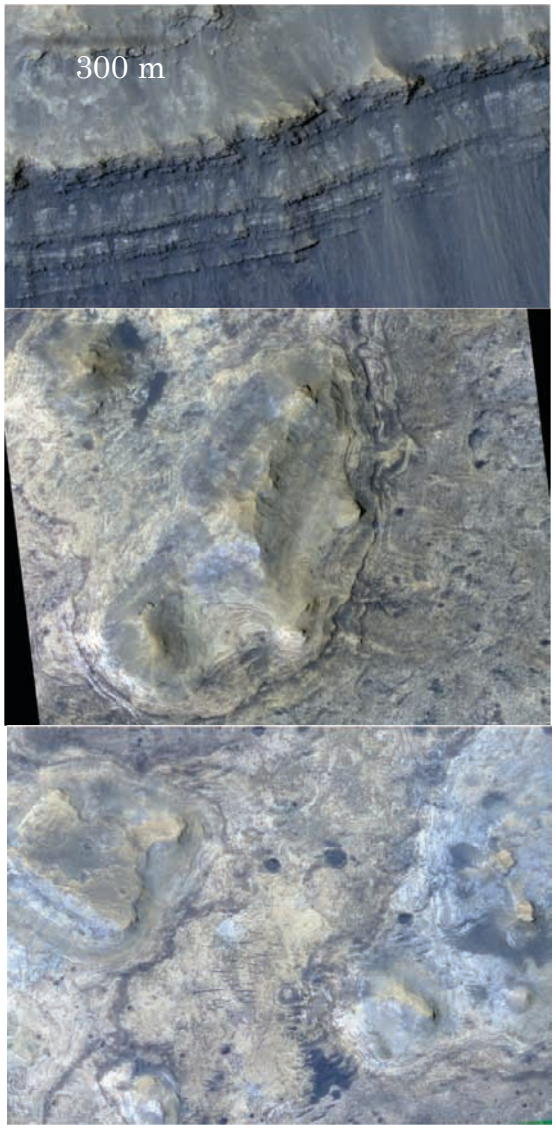


GEOMORPHOLOGY OVERVIEW

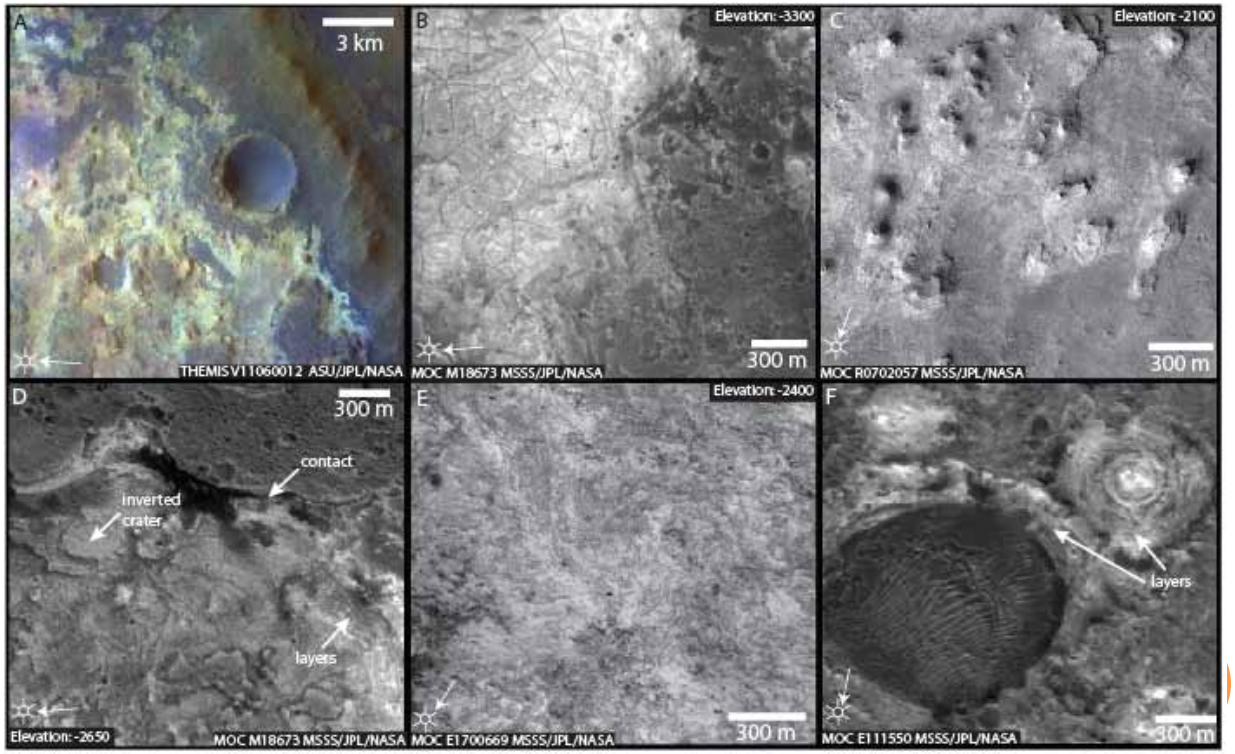
- Layers everywhere
- Many expressions of layered units
- Erosion and redeposition by fluvial and eolian activity



GEOMORPHOLOGY AND LITHOLOGY OF THE CLAY-BEARING ROCKS



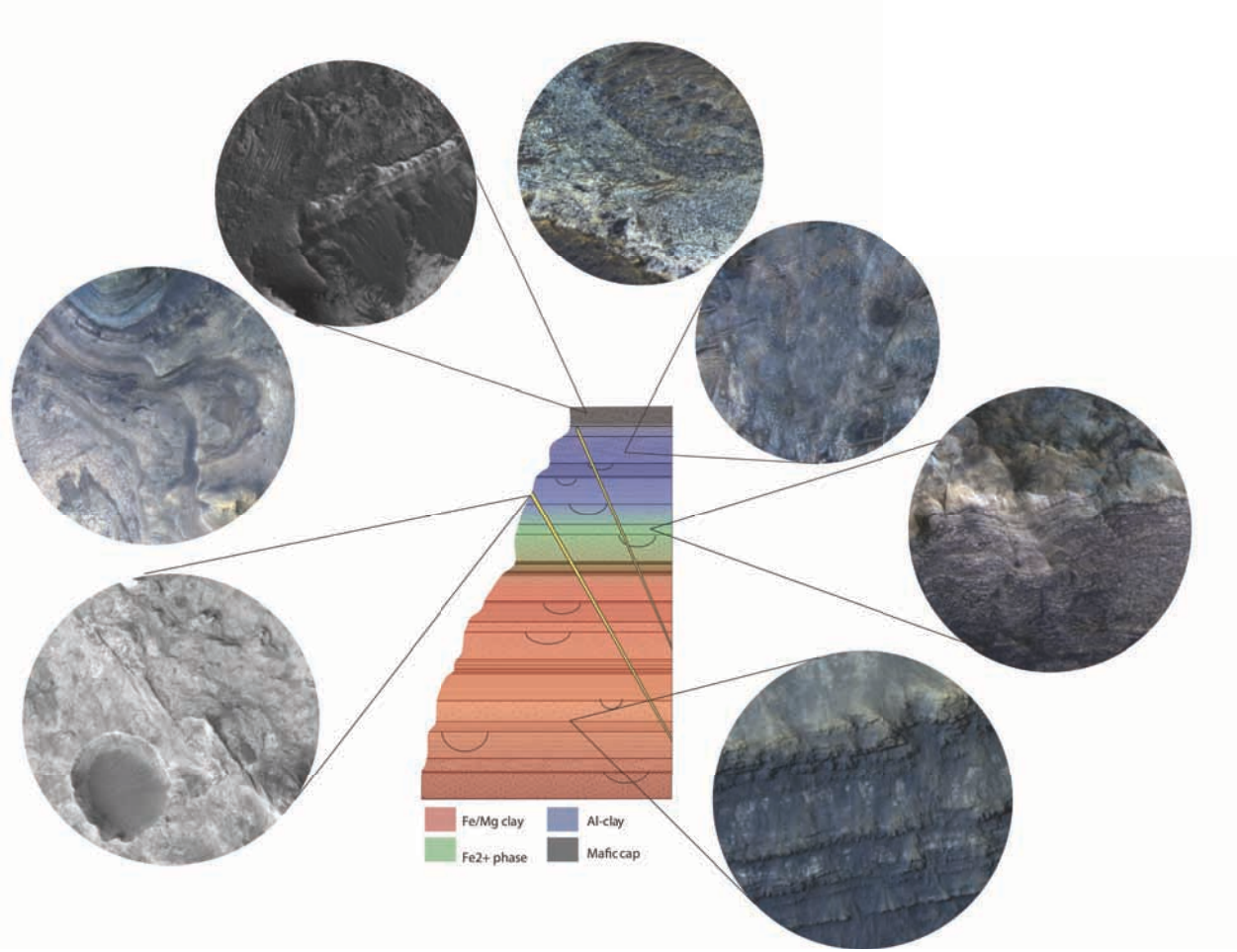
- There are a number of geomorphic expressions that indicate a range of lithologies



Michalski and Noe Dobrea, *Geology*, 2007

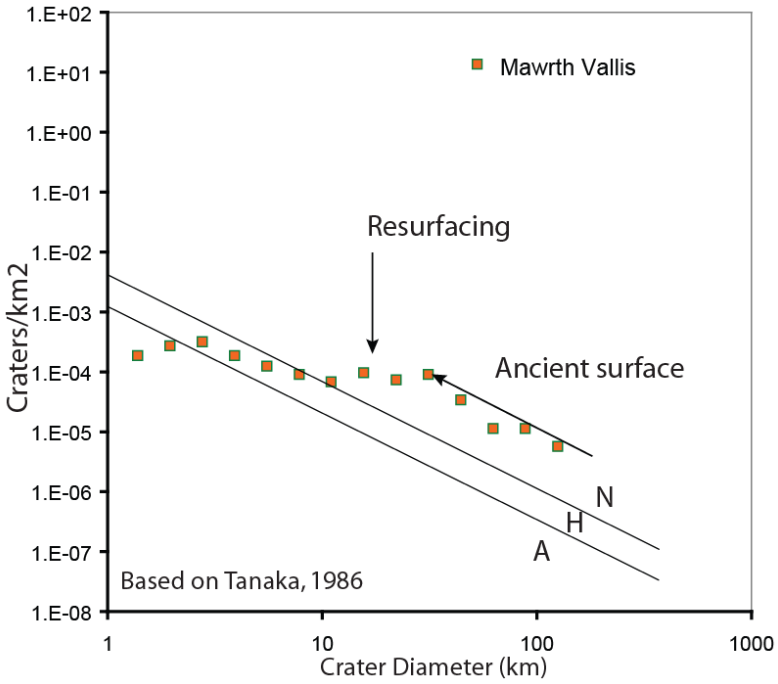
MULTIPLE SCIENCE TARGETS

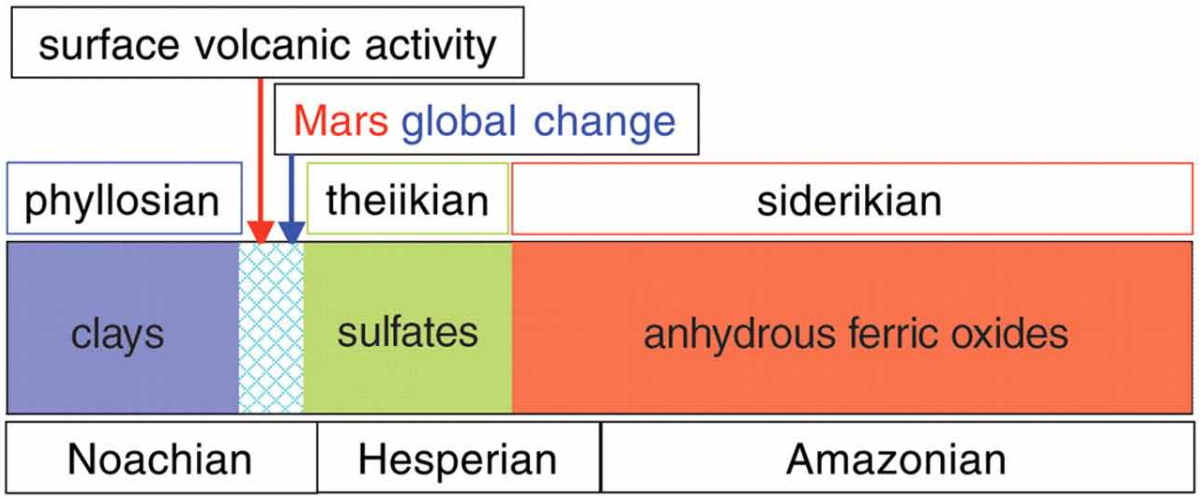
- Hedge our bets by visiting multiple targets, each with intrinsic merit



TRAVERSING MARS' AQUEOUS HISTORY

- Ancient, in-situ bedrock
- Younger, reworked, clay-bearing rocks
- Sulfate-bearing rocks
- Hesperian, dark cap unit





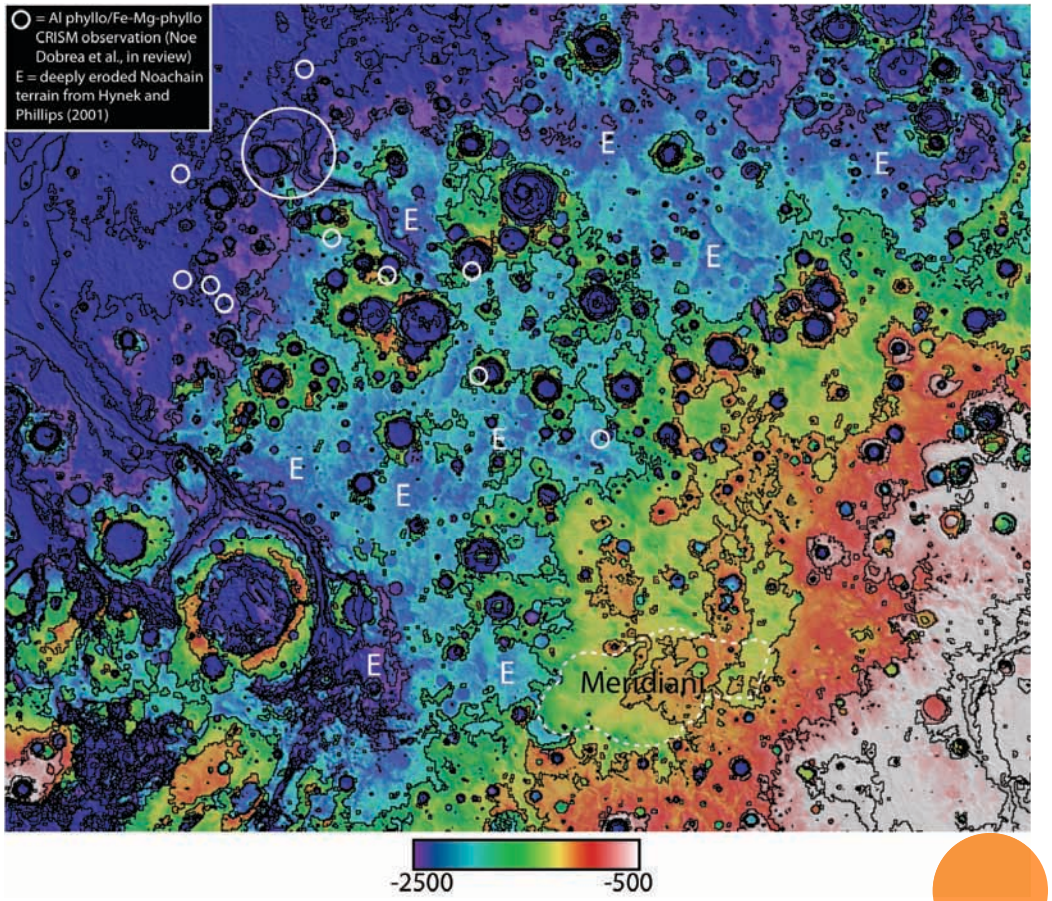
WHY DO WE SEE SPECIAL GEOLOGY AT MAWRTH VALLIS?

- Localized environment?

  Or

- **Unusual erosion of the region**?

- Connection to the global picture



TESTABLE HYPOTHESES

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

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