Huygens Crater: Insights into Noachian Volcanism, Stratigraphy, and Aqueous Processes

Workshop Abstract #1032

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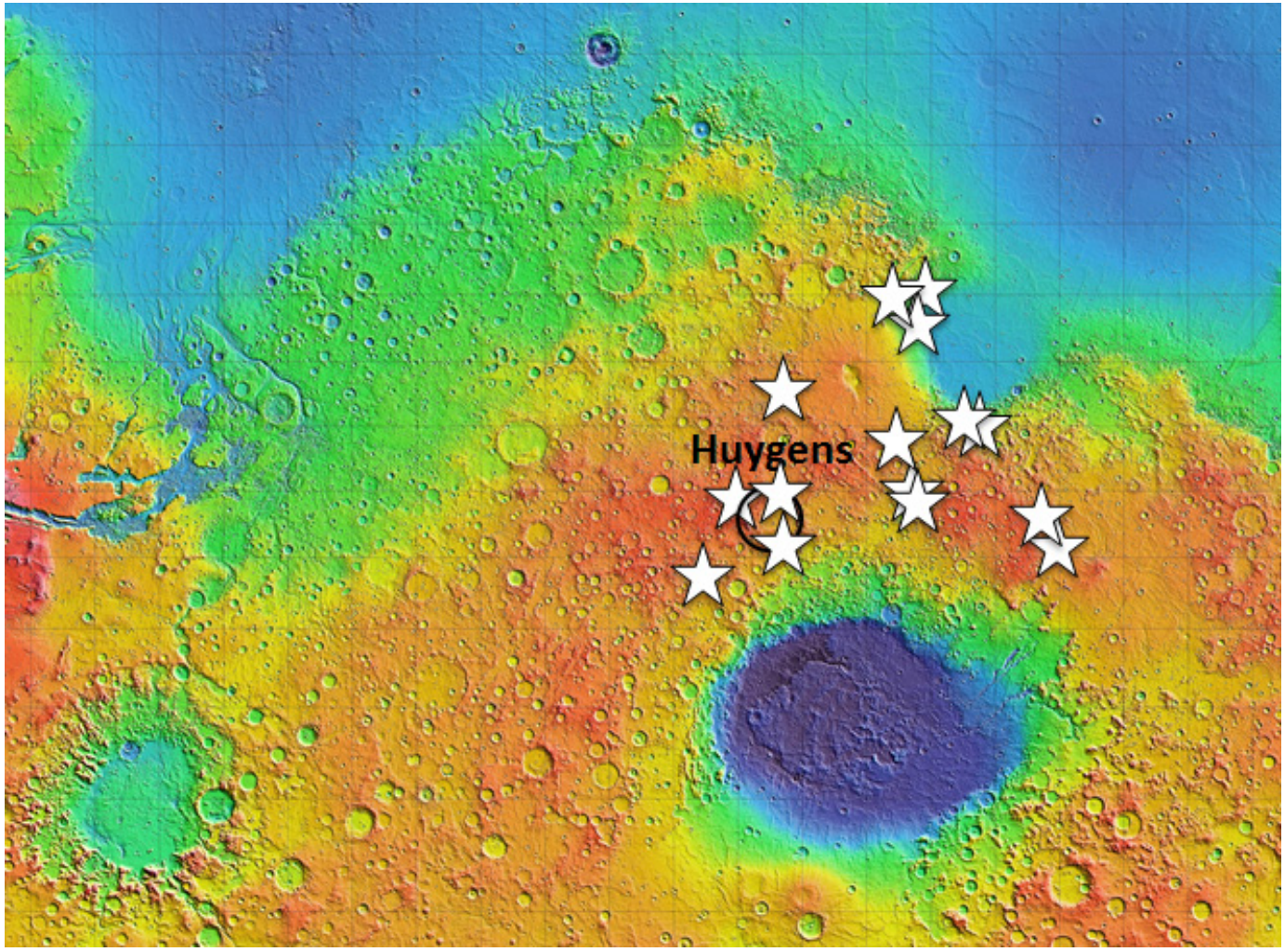
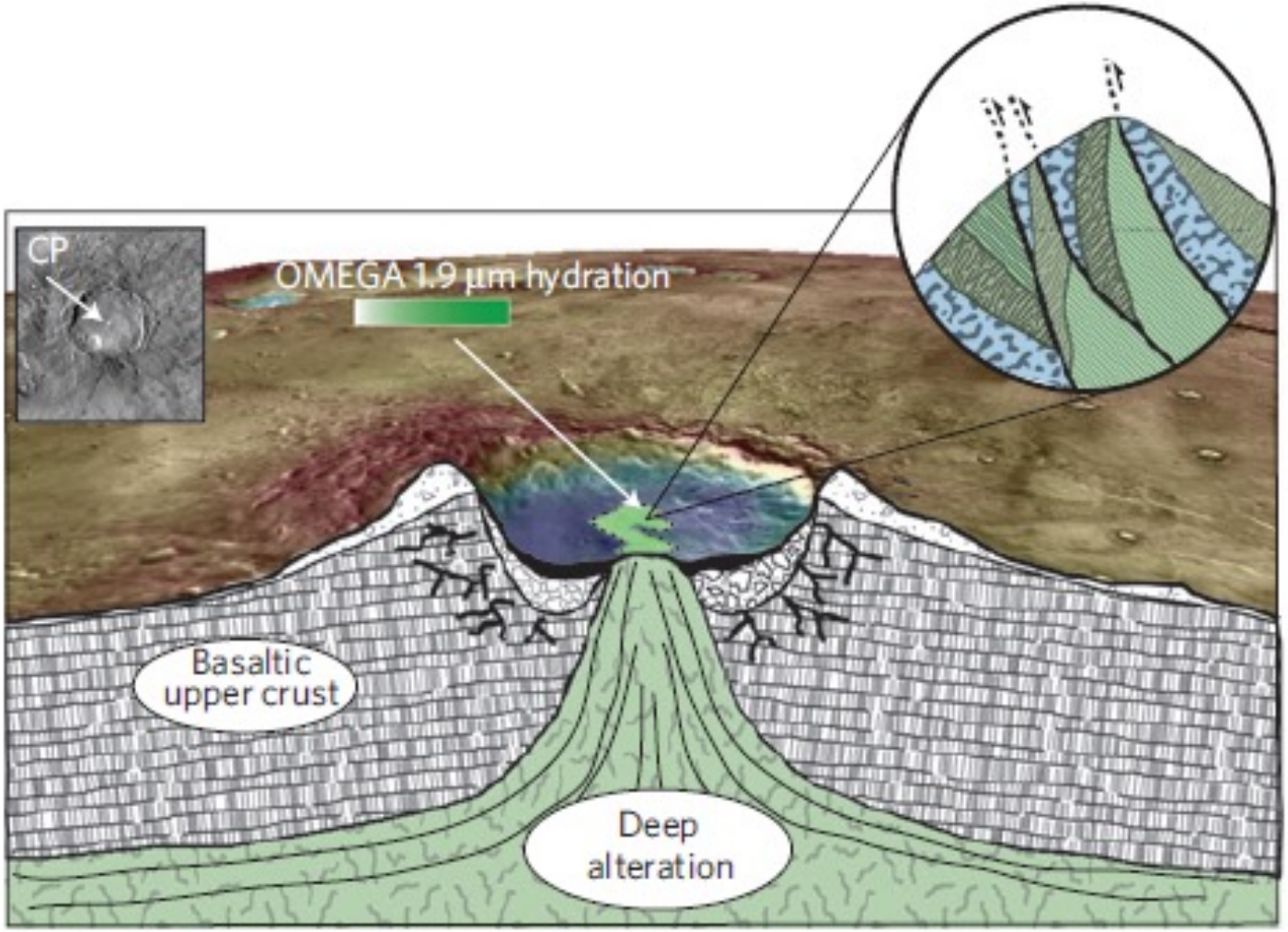
Regional occurrences of carbonates



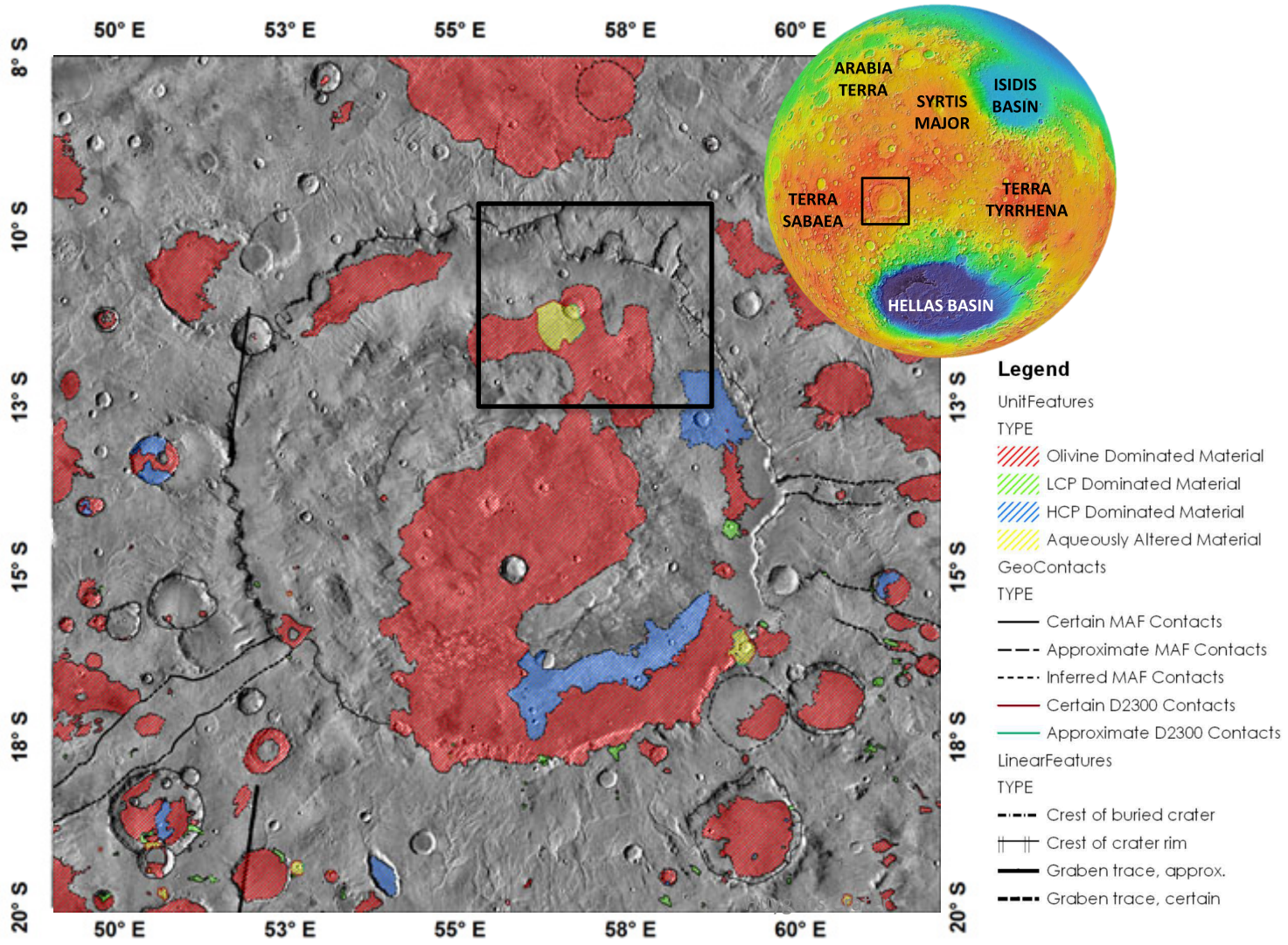
Ehlmann et al., 2008; Niles et al., 2013; Wray et al., 2011; Michalski and Niles, 2010; Carrozzo et al., 2013

Buried Carbonate Layers

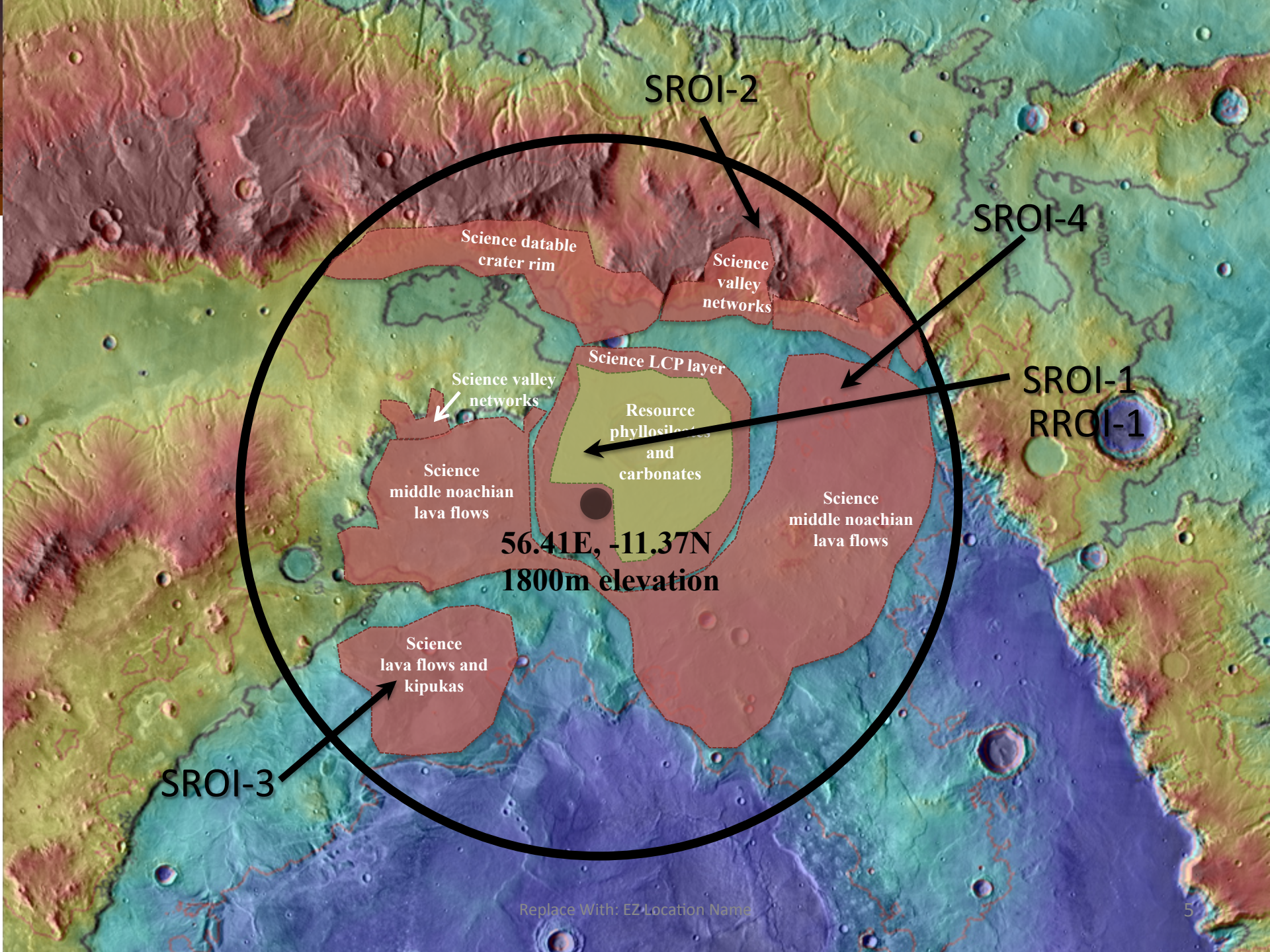


Michalski and Niles (2010)

Mineralogy of Huygens crater



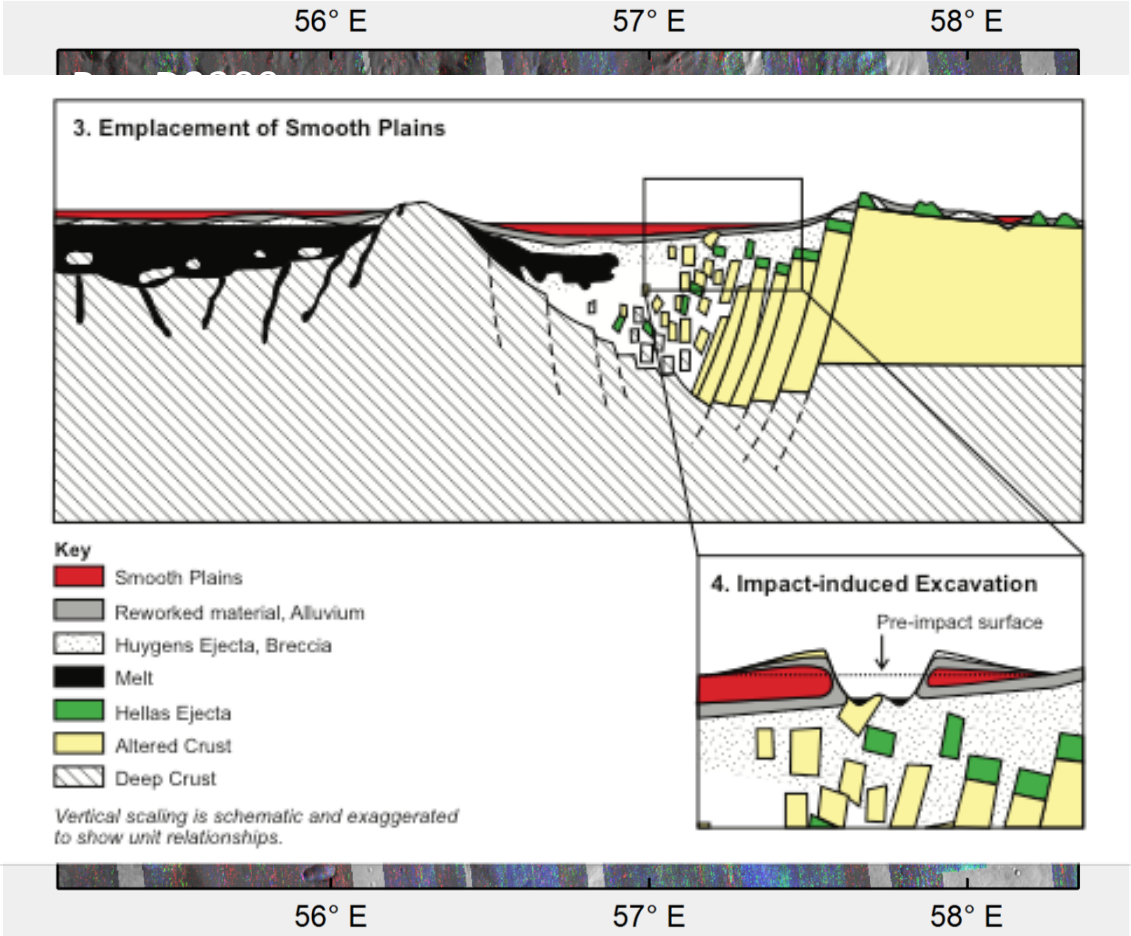
Ackiss et al., 2014


SROI-2
SROI-4
SROI-1
RROI-1
SROI-3
Science datable crater rim
Science valley networks
Science LCP layer
Science valley networks
Resource phyllosil and carbonates
Science middle noachian lava flows
Science middle noachian lava flows
56.41E, -11.37N
1800m elevation
Science lava flows and kipukas

[in order of priority: addressing threshold first, then qualifying]

SCIENCE ROIs

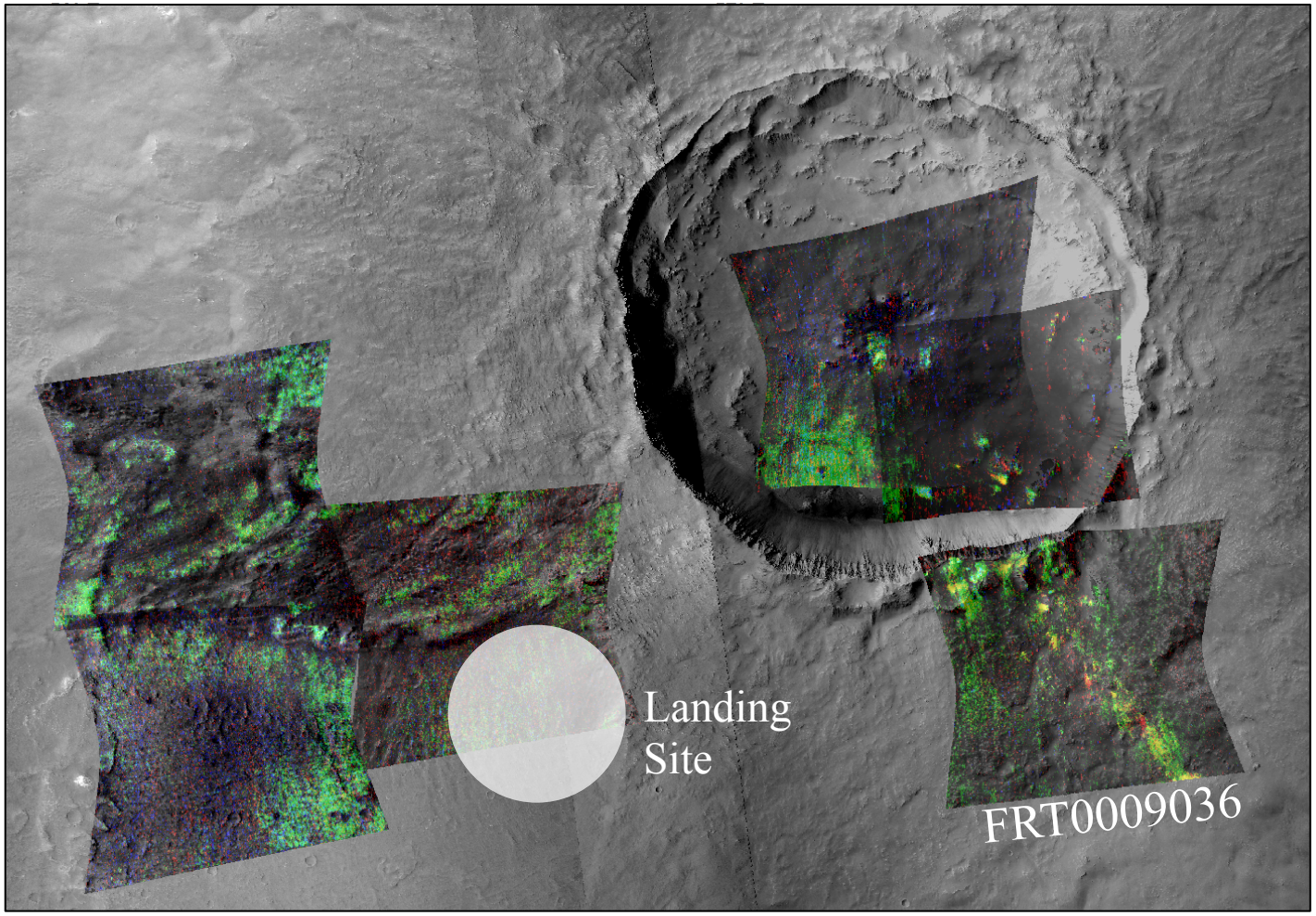
Pyroxene layer under phyllosilicate ejecta



- 57.04E, -11.52N
- 1.77 km elevation
- Mafic pyroxene-rich layer under the phyllosilicates could be showing a sampling of Hellas ejecta or a plains unit

CRISM mapping data summary parameters over THEMIS daytime IR

Phyllosilicate and Carbonate SROI-1



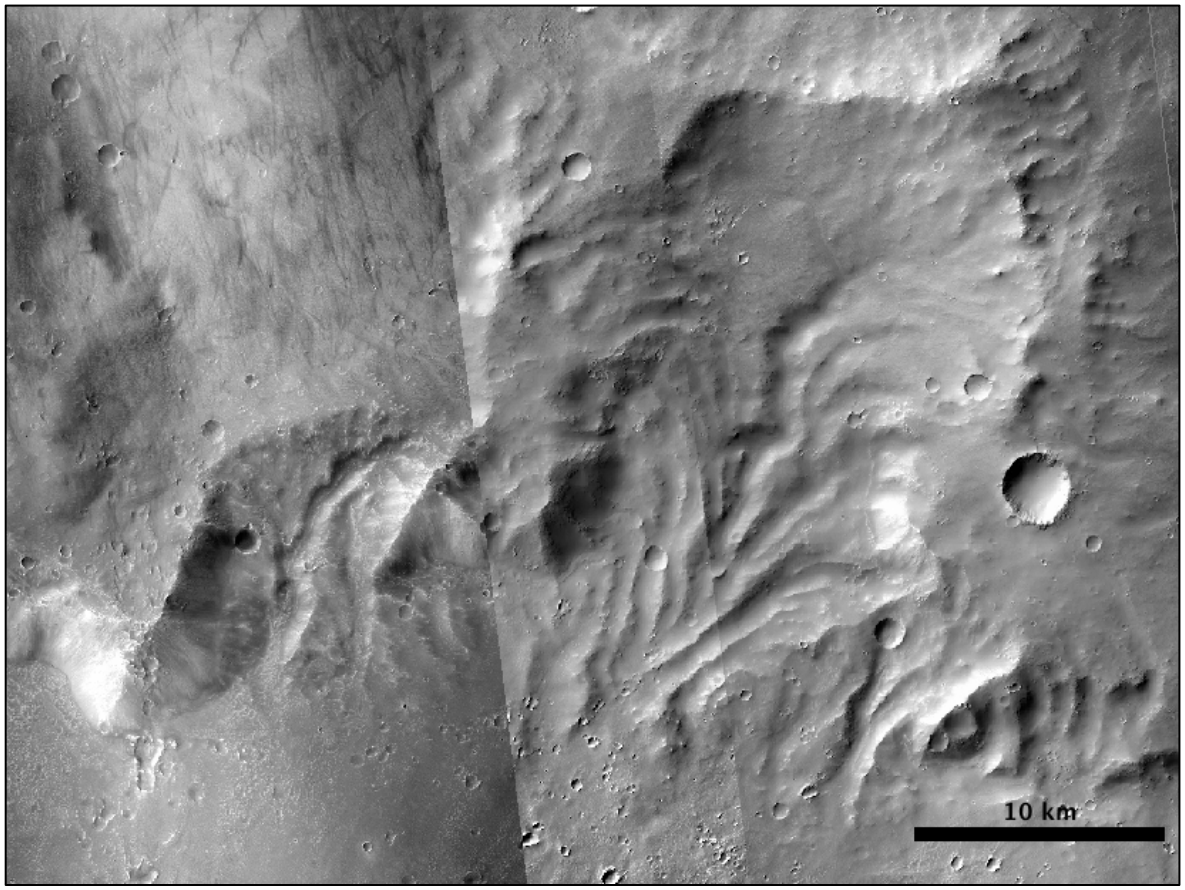
CRISM PFM parameter map showing

R: BD2355,

G: D2300,

B: BD2290. The scene contains a wide variety of resources including carbonates, kaolinite, smectites, and chlorite.

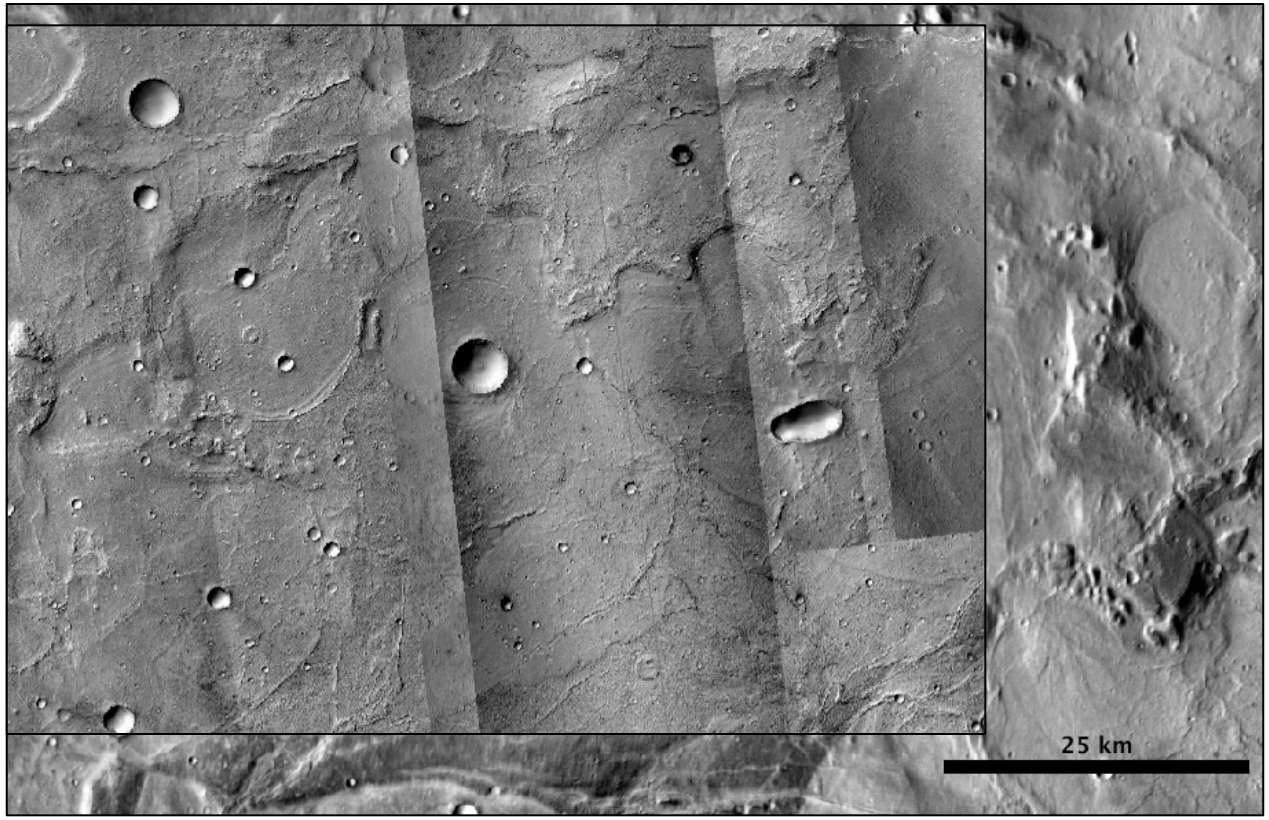
Datable crater rim and valley networks SROI-2



57.1E, -10.34N
2000m; on rim
CTX data

- All along the crater rim are valley networks
- These networks have no associated spectral signature and very little HiRISE coverage

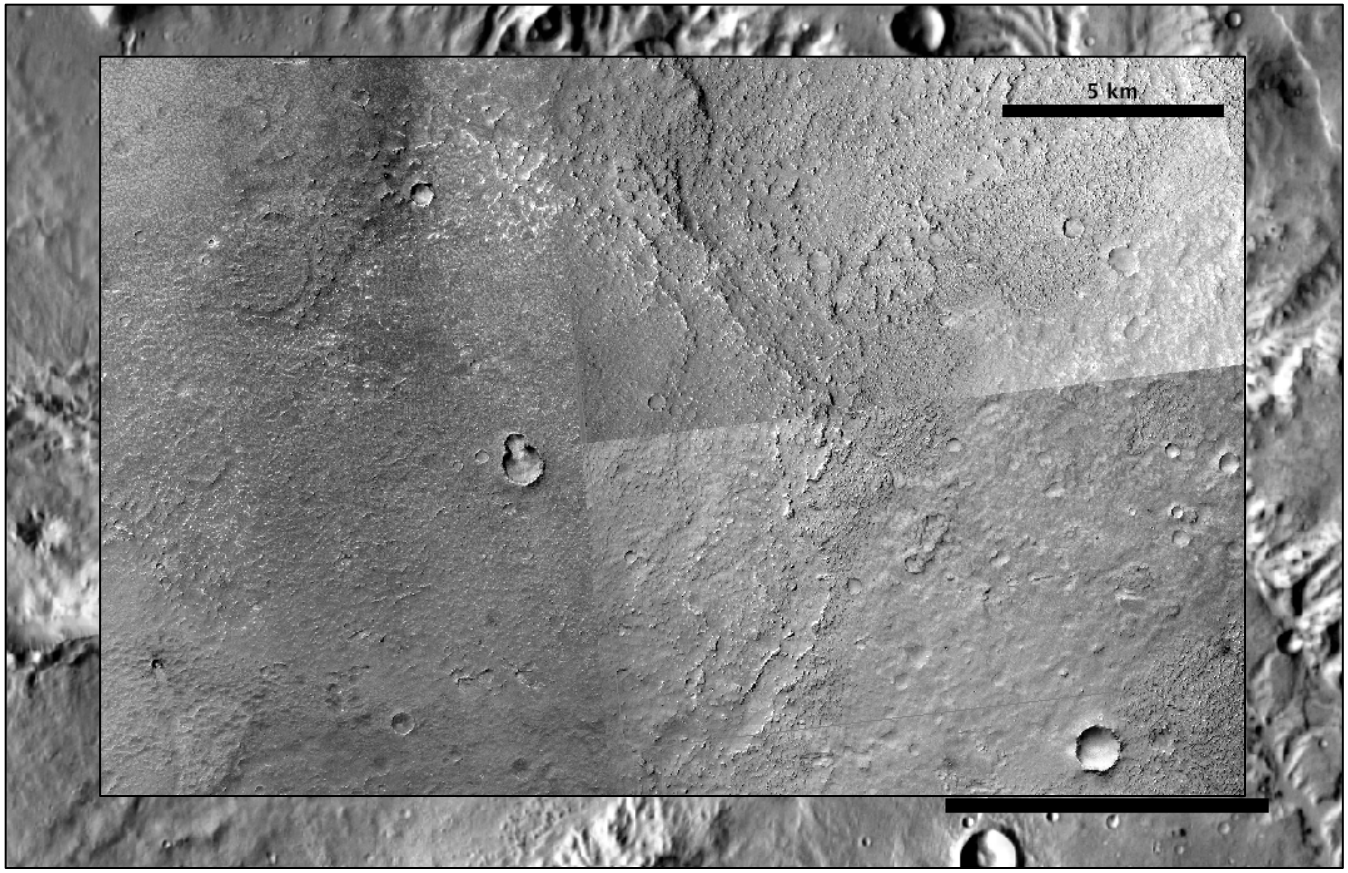
Volcanic Melt Islands SROI-3



55.71E, -12.31N
1.71 km elevation
THEMIS Day IR and CTX data

- <Kim and I are still unsure about what these are. We've thought they might be impact melt but later scratched that because of the timing.>

Olivine-rich plains units SROI-4



- High thermal inertia with little eolian materials
- Spectrally dominated by olivine but often mixed/ gradational with high calcium pyroxene.

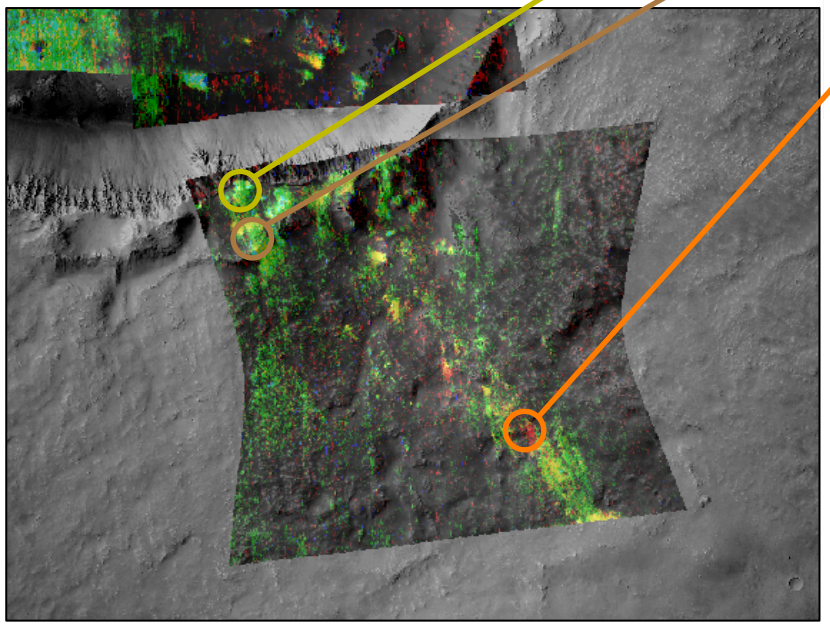
57.65E, -11N
1.53 km elevation
THEMIS Day IR and CTX data

[in order of priority: addressing threshold first, then qualifying]

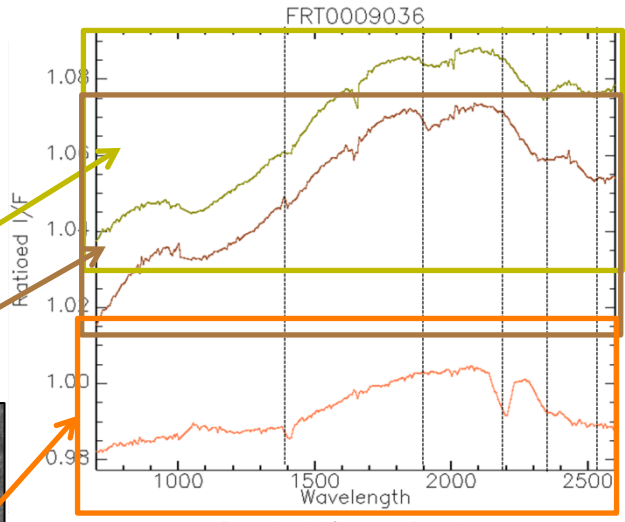
RESOURCE ROIs

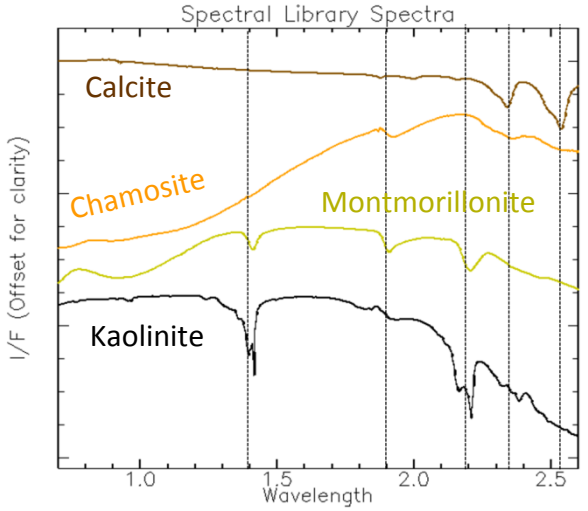
Spectral diversity surrounding this unnamed crater RROI-1

- Land on resource minerals (carbonate and/or chlorite)
- More diversity roughly 15km from the landing site.
- Crater rim lies at 2km elevation while the ejecta is 1.84km elevation



FRT0009036 (R: BD2355, G: D2300, B: BD2290) over CTX image P12_005724_1678_xi_12S303W.





Huygens Crater

RUBRICS

Science ROI(s) Rubric

1st EZ Workshop for Human Missions to Mars

Science Site Criteria				Site Factors	SROI1	SROI2	SROI3	SROI4	RROI1	EZ SUM
	Astrobio	Threshold	AND/OR	**Potential for past habitability**	●	●	●	●	●	
				Potential for present habitability/refugia						
		Qualifying		Potential for organic matter, w/ surface exposure	●	●	●	●	●	
	Atmospheric Science	Threshold		**Noachian/Hesperian rocks w/ trapped atmospheric gases**	●	●	●	●	●	
		Qualifying		Meteorological diversity in space and time	●	●	●	●	●	
				High likelihood of surface-atmosphere exchange	●	●	●	●	●	
				Amazonian subsurface or high-latitude ice or sediment						
				High likelihood of active trace gas sources	●	●	●	●	●	
	Geoscience	Threshold		**Range of martian geologic time; datable surfaces**	●	●	●	●	●	
				Evidence of aqueous processes	●	●	●	●	●	
				Potential for interpreting relative ages	●	●	●	●	●	
		Qualifying		Igneous Rocks tied to 1+ provinces or different times	●	●	●	●	●	
				Near-surface ice, glacial or permafrost						
				Noachian or pre-Noachian bedrock units	●	●	●	●	●	
				Outcrops with remnant magnetization						
				Primary, secondary, and basin-forming impact deposits	●	●	●	●	●	
				Structural features with regional or global context	●	●	●	●	●	
				Diversity of aeolian sediments and/or landforms	●	●	●	●	●	

Key	
●	**Yes**
○	**Partial Support or Debated**
	No
?	**Indeterminate**

Resource ROI(s) Rubric

1st EZ Workshop for Human Missions to Mars

				Site Factors	SROI1	SROI2	SROI3	SROI4	RROI1	EZ SUM
ISRU and Civil Engineering Criteria	Engineering			Meets First Order Criteria (Latitude, Elevation, Thermal Inertia)	●	●	●	●	●	
	Water Resource	Threshold	AND/OR	**Potential for ice or ice/regolith mix**						
				Potential for hydrated minerals	●				●	
				Quantity for substantial production	○				○	
				Potential to be minable by highly automated systems	●				●	
				Located less than 3 km from processing equipment site	●				●	
				Located no more than 3 meters below the surface	●				●	
				Accessible by automated systems	●				●	
		Qualifying		Potential for multiple sources of ice, ice/regolith mix **and** hydrated minerals						
				Distance to resource location can be >5 km	●				●	
				Route to resource location must be (plausibly) traversable	●				●	
	Civil Engineering	Threshold		**~50 sq km region of flat and stable terrain with sparse rock distribution**	●				●	
				1–10 km length scale: <10°	●				●	
				Located within 5 km of landing site location	●				●	
		Qualifying		Located in the northern hemisphere						
				Evidence of abundant cobble sized or smaller rocks and bulk, loose regolith	●	●	●	●	●	
				Utilitarian terrain features	●	●	●	●	●	
	Food Production	Qualifying		Low latitude	●	●	●	●	●	
				No local terrain feature(s) that could shadow light collection facilities	●	●	●	●	●	
				Access to water	●				●	
				Access to dark, minimally altered basaltic sands	●	●	●	●	●	
	Metal/Silicon Resource	Threshold		**Potential for metal/silicon**	○	○	○	○	○	
				Potential to be minable by highly automated systems	○	○	○	○	○	
				Located less than 3 km from processing equipment site	○	○	○	○	○	
				Located no more than 3 meters below the surface	○	○	○	○	○	
				Accessible by automated systems	○	○	○	○	○	
		Qualifying		Potential for multiple sources of metals/silicon	○	○	○	○	○	
				Distance to resource location can be >5 km	○	○	○	○	○	
				Route to resource location must be (plausibly) traversable	○	○	○	○	○	

Key	
●	**Yes**
○	**Partial Support or Debated**
	No
?	**Indeterminate**

Highest Priority EZ Data Needs

- More coverage by HiRISE and CRISM
  - *Detection of altered Noachian Crust*
  - *Differentiation between Hellas Ejecta*
  - *Subsurface Geology*
- Major Subsurface Story (Radar, Lander)
  - *Buried Carbonate Units*
  - *Effects of Huygens Crater Structures*
  - *Sources of lava flows*
  - *Hydrothermal systems?*

BACKUP SLIDES