

Human Exploration of Valles Marineris: The Past, Present, and Future of Life on Mars (#1036)

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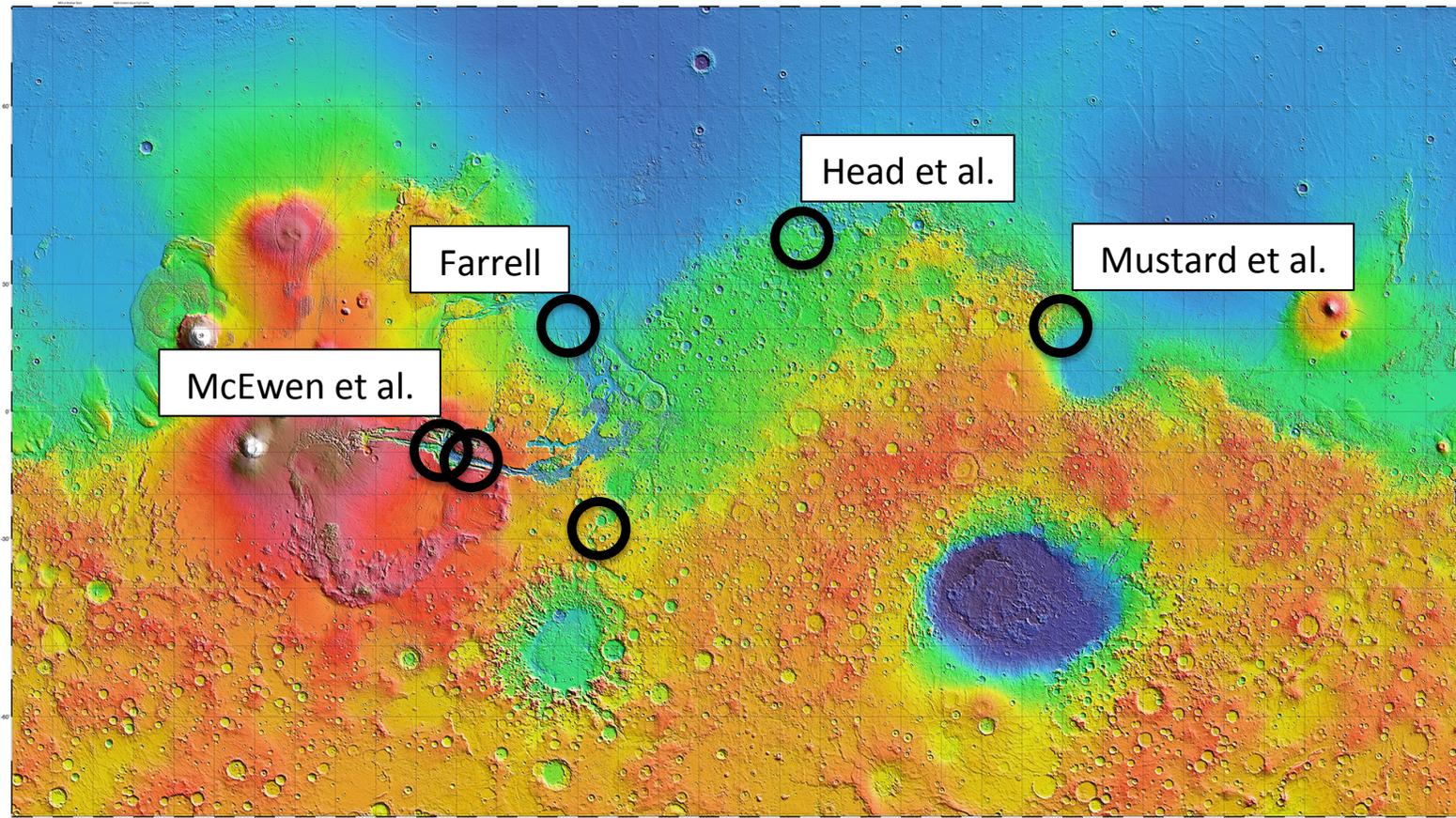
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Sites We Considered

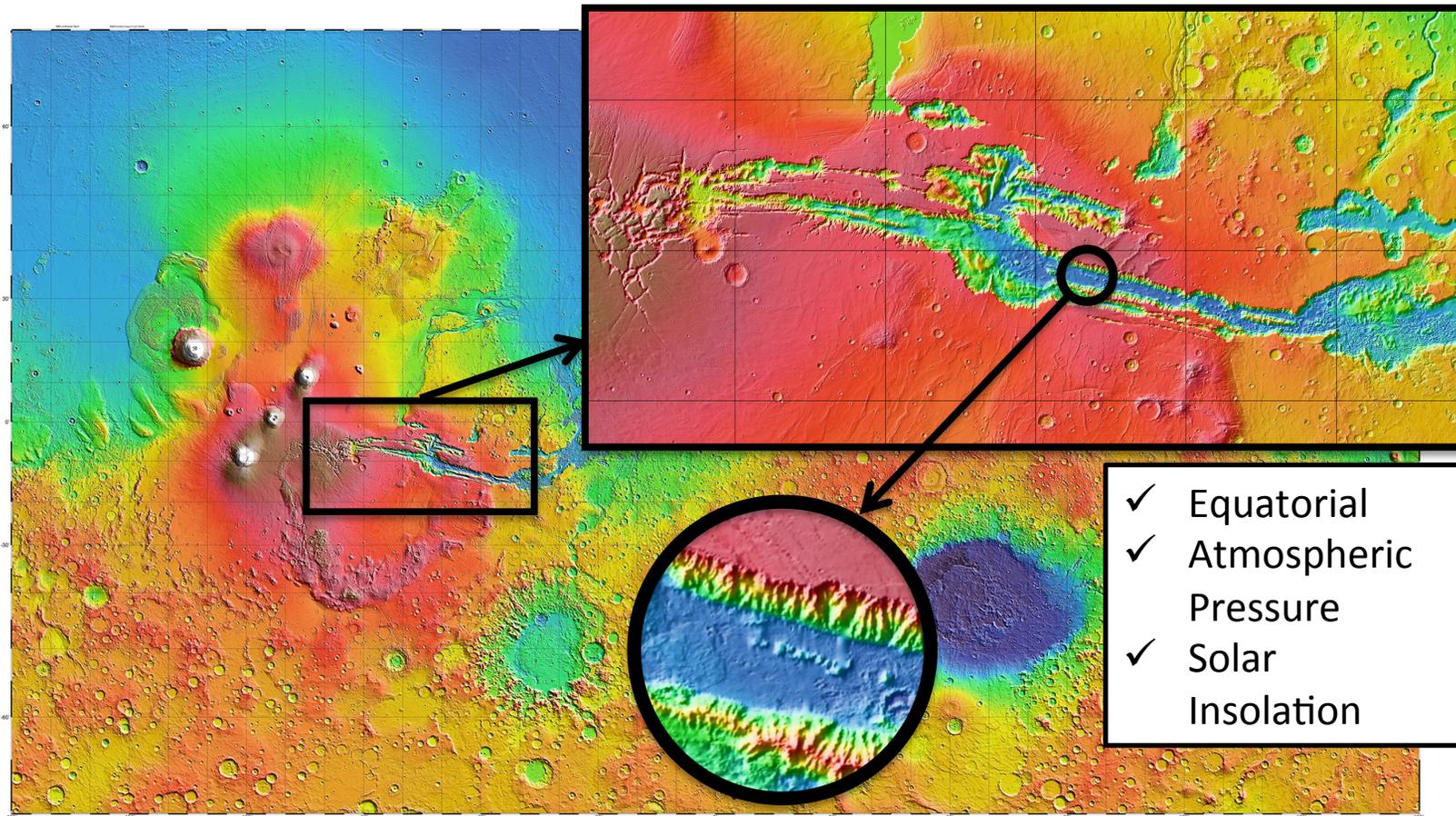
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MOLA/NASA

Valles Marineris

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MOLA/NASA

Fog & Recurring Slope Lineae (RSL)

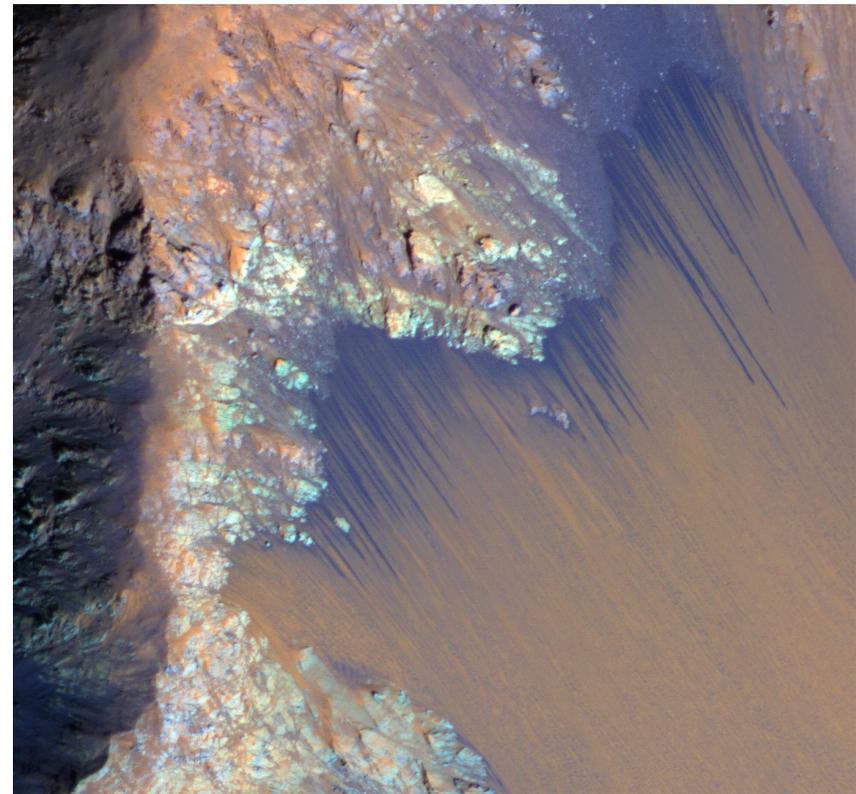
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Fog - Water Ice



HRSC/MEX/ESA

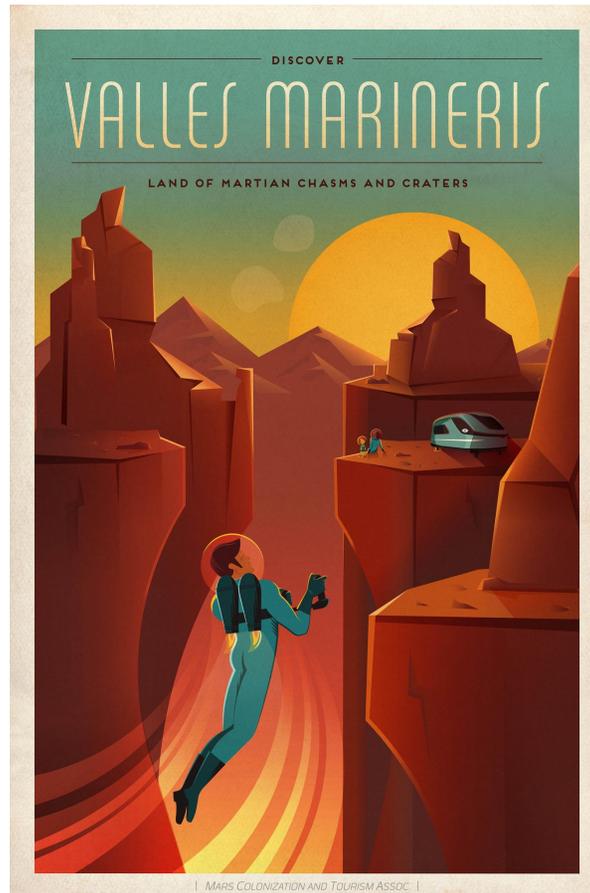
RSLs - Liquid Water



HiRISE NASA/JPL/ASU/MSSS

Great Place to Visit!

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SpaceX

Exploration Zone Map #1036

1st EZ Workshop for Human Missions to Mars

Landing Site:

293.440°E,
-11.760°N

Altitude: -4.8km

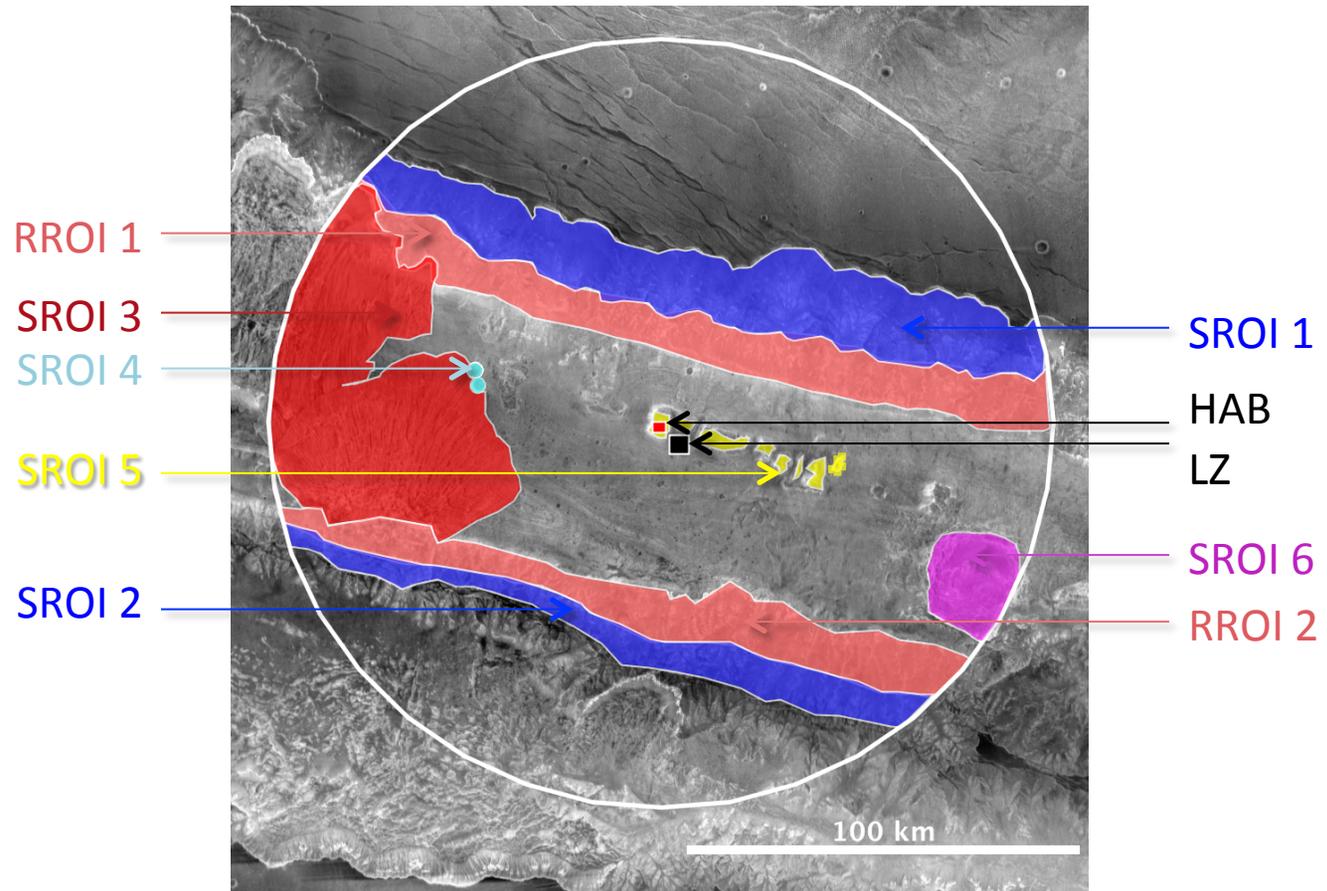
Legend:

SROI: Science
Region of Interest

RROI: Resource
Region of Interest

HAB: Habitation
Zone

LZ: Landing Zone



Science ROI(s) Rubric

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			Site Factors									
			SROI1	SROI2	SROI3	SROI4	SROI5	SROI6	RROI1	RROI2	EZ SUM	
Science Site Criteria	Astrobio	Threshold	AND/OR	Potential for past habitability								6,1
			Potential for present habitability/refugia								5,2	
		Qualifying	Potential for organic matter, w/ surface exposure								7,0	
	Atmospheric Science	Threshold	Noachian/Hesperian rocks w/ trapped atmospheric gases								7,0	
			Meteorological diversity in space and time								2,0	
		Qualifying	High likelihood of surface-atmosphere exchange								5,0	
			Amazonian subsurface or high-latitude ice or sediment								5,0	
			High likelihood of active trace gas sources								0,0	
	Geoscience	Threshold	Range of martian geologic time; datable surfaces								8,0	
			Evidence of aqueous processes								8,0	
			Potential for interpreting relative ages								8,0	
		Qualifying	Igneous Rocks tied to 1+ provinces or different times								7,0	
			Near-surface ice, glacial or permafrost								7,0	
			Noachian or pre-Noachian bedrock units								7,0	
Outcrops with remnant magnetization								5,2				
Primary, secondary, and basin-forming impact deposits								3,0				
Structural features with regional or global context								6,0				
Diversity of aeolian sediments and/or landforms								8,0				

Key	
●	Yes
○	Partial Support or Debated
	No
?	Indeterminate

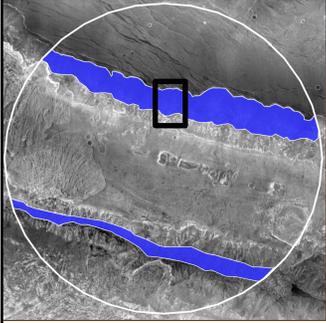
Resource ROI(s) Rubric

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Site Factors			SROI1	SROI2	SROI3	SROI4	RROI5	RROI6	RROI1	RROI1	EZ SUM			
ISRU and Civil Engineering Criteria	Engineering	Meets First Order Criteria (Latitude, Elevation, Thermal Inertia)										6,0		
	Water Resource	Threshold	AND/OR	Potential for ice or ice/regolith mix										5,3
			Potential for hydrated minerals										8,0	
			Quantity for substantial production										7,1	
			Potential to be minable by highly automated systems										5,3	
			Located less than 3 km from processing equipment site										1,0	
			Located no more than 3 meters below the surface										8,0	
		Accessible by automated systems										5,3		
		Qualifying	Potential for multiple sources of ice, ice/regolith mix and hydrated minerals										7,1	
			Distance to resource location can be >5 km										8,0	
			Route to resource location must be (plausibly) traversable										7,2	
	Civil Engineering	Threshold	~50 sq km region of flat and stable terrain with sparse rock distribution										2,0	
			1-10 km length scale: <10°										3,0	
			Located within 5 km of landing site location										1,0	
		Qualifying	Located in the northern hemisphere										8,0	
	Evidence of abundant cobble sized or smaller rocks and bulk, loose regolith										6,0			
	Food Production	Qualifying	Utilitarian terrain features										6,0	
			Low latitude										8,0	
			No local terrain feature(s) that could shadow light collection facilities										7,1	
			Access to water										4,3	
	Metal/Silicon Resource	Threshold	Access to dark, minimally altered basaltic sands										2,6	
			Potential for metal/silicon										8,0	
			Potential to be minable by highly automated systems										6,2	
Located less than 3 km from processing equipment site										1,0				
Located no more than 3 meters below the surface										8,0				
Accessible by automated systems										5,3				
Qualifying		Potential for multiple sources of metals/silicon										8,0		
	Distance to resource location can be >5 km										8,0			
	Route to resource location must be (plausibly) traversable										6,2			

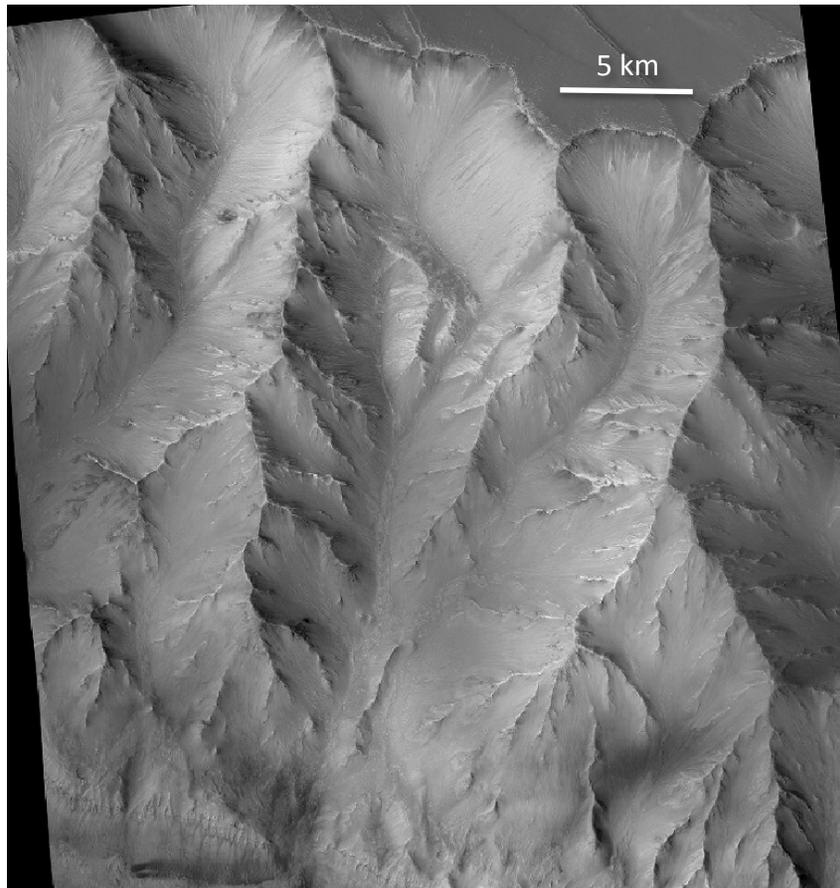
Key	
●	Yes
○	Partial Support or Debated
	No
?	Indeterminate

Landing Site meets all requirements



SROI 1 & 2 – Valley Walls

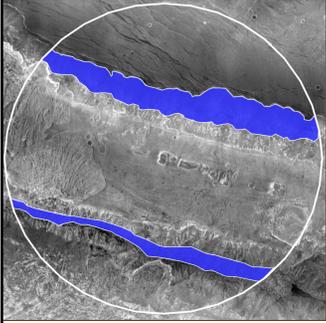
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CTX NASA/JPL/ASU/MSSS

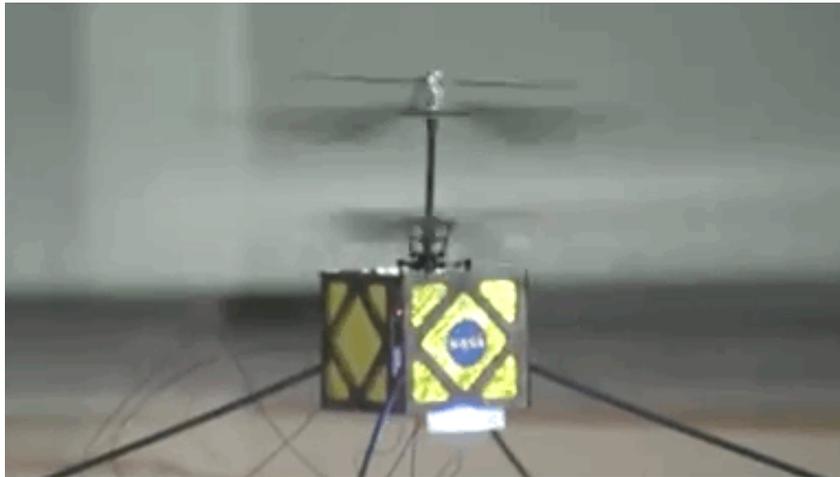
- Great exposures of Noachian and Hesperian stratigraphy on Mars
- High density of RSLs
- Great site to search for extant life

North Wall: 293.895°E, -11.090°N
Southern Wall: 29.191°E, -12.621°N

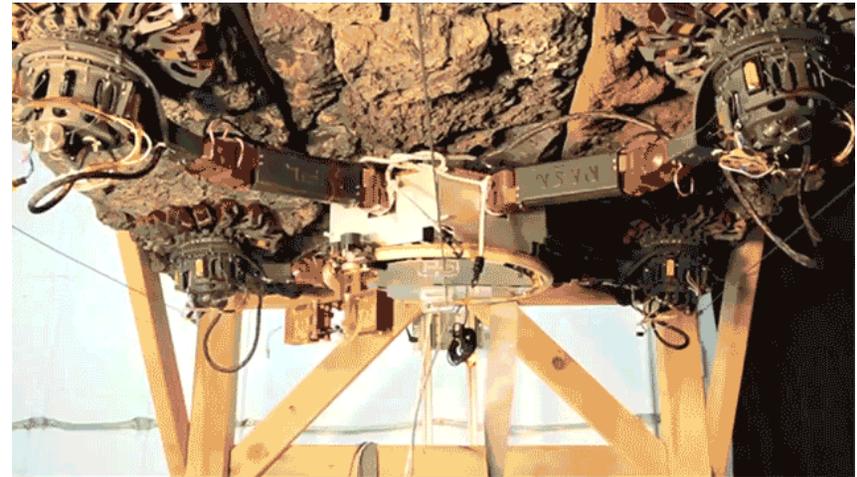


RSL Sampling

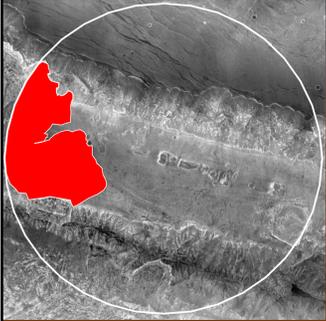
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NASA/JPL

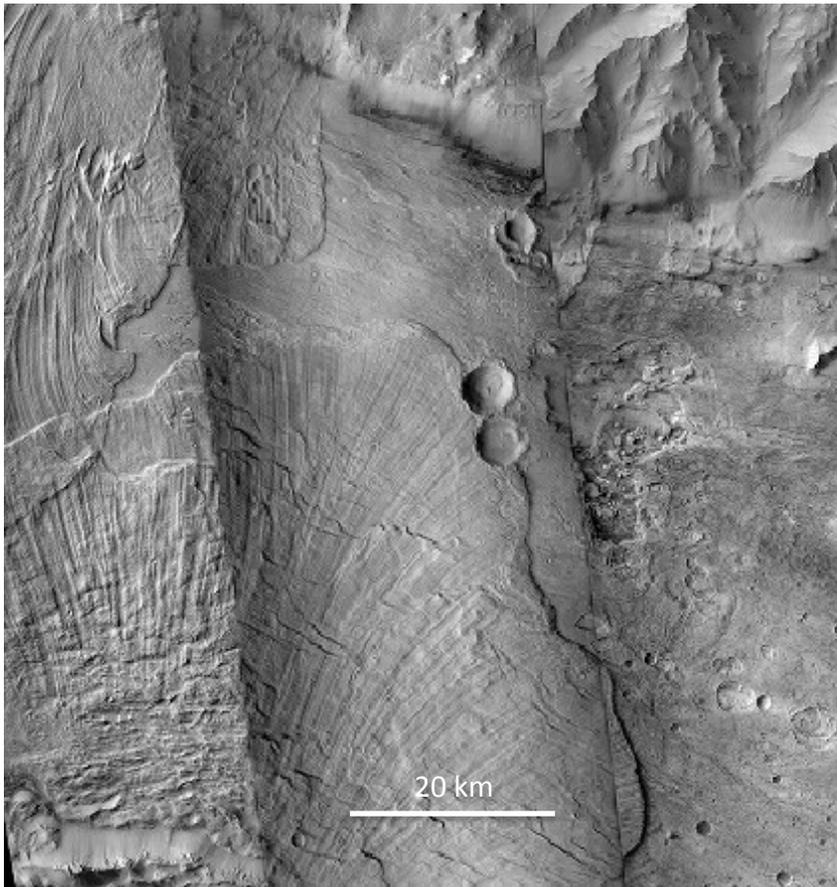


NASA/JPL



SROI 3 – Alluvial Fans

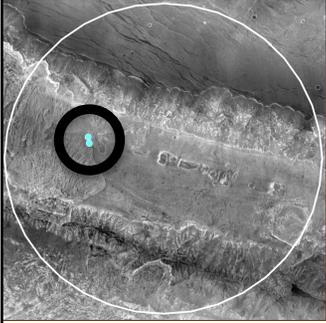
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CTX NASA/JPL/ASU/MSSS

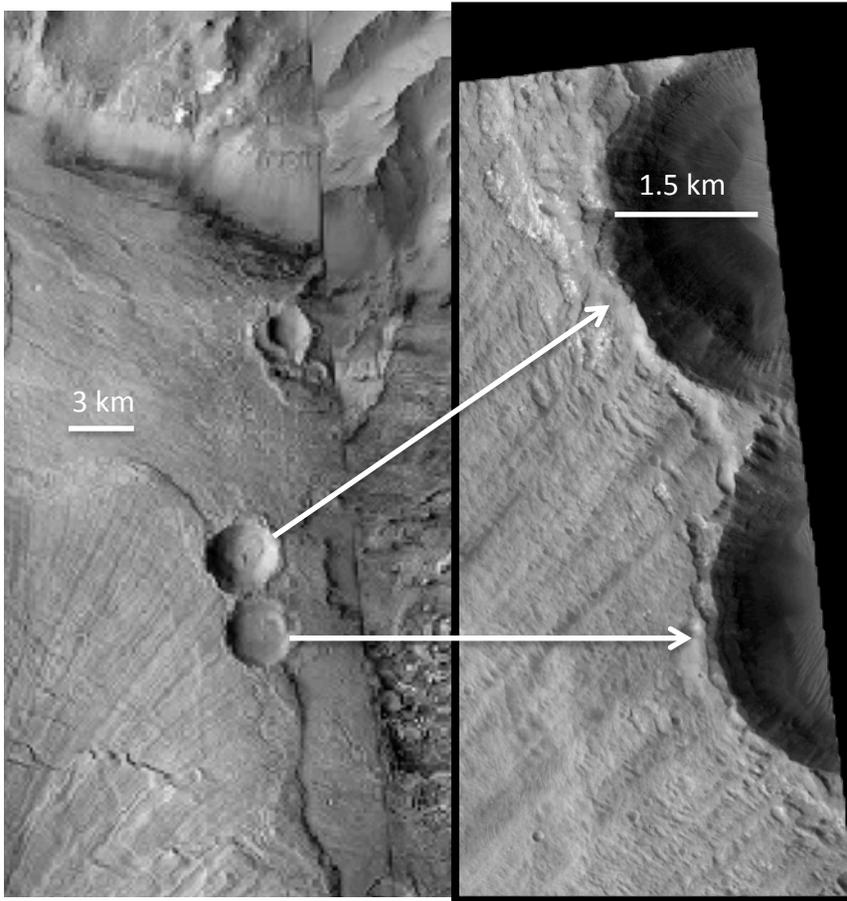
- Cross-cutting Amazonian-age alluvial fans
- Potential for preserved subsurface life
- Diverse valley wall lithology deposits

Coprates Labes: 292.207°E, -11.779°N
Ophir Labels: 291.869°E, -11.068°N



SROI 4 – Twin Craters

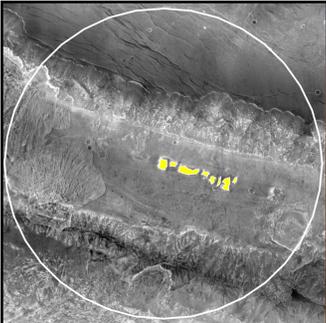
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CTX HiRISE NASA/JPL/ASU/MSSS

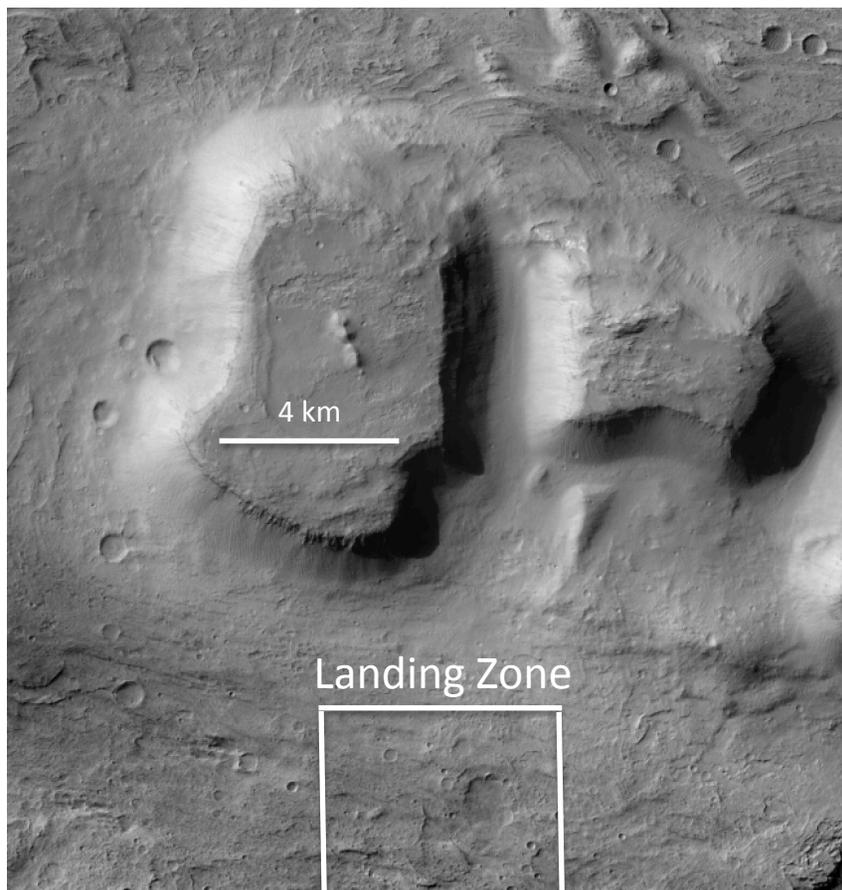
- Potential sites of accessible RSL activity
 - Similar to Garni Crater
- Exposed basin stratigraphy
- Preserved organics in Impact glass?
 - Mustard and Cannon 2015

North Crater: 292.552°E, -11.140°N
South Crater: 292.568°E, -11.505°N



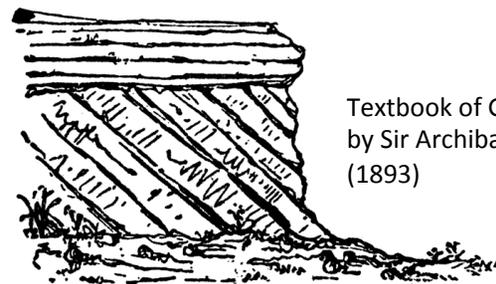
SROI 5 – Fault Blocks

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CTX NASA/JPL/ASU/MSSS

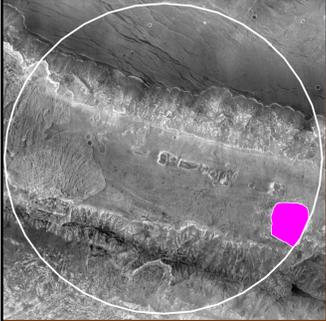
- Easily accessible Noachian/Hesperian Stratigraphy
 - Tilted block?



Textbook of Geology
by Sir Archibald Geikie
(1893)

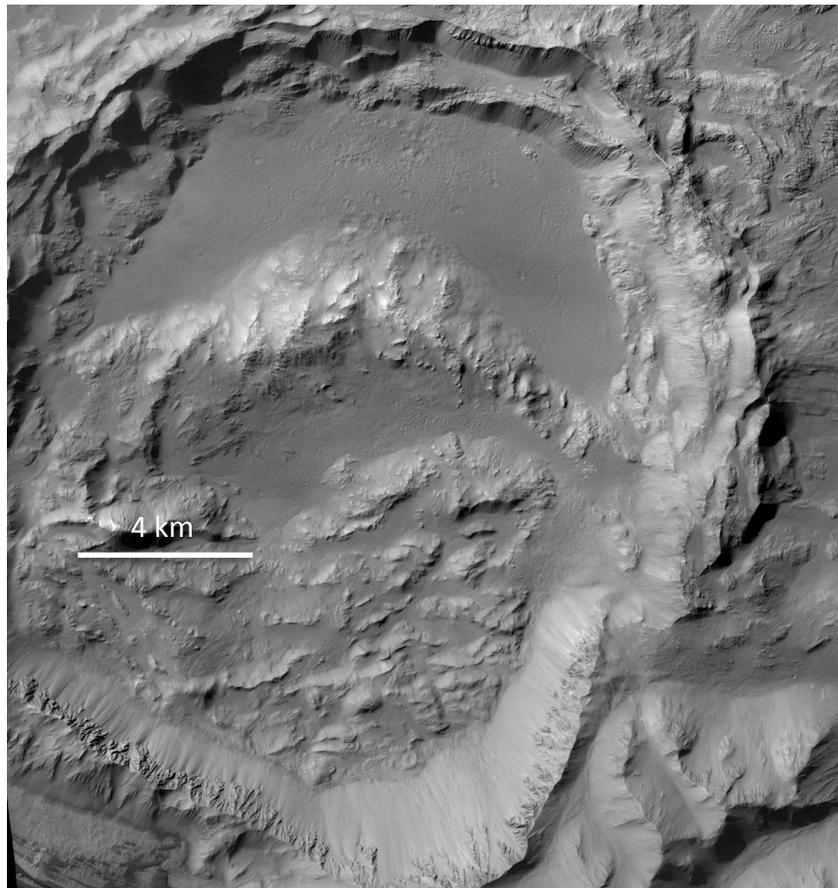
- Resources and Shelter

Westernmost block: 293.351E, -11.666N



SROI 6 – Impact Crater

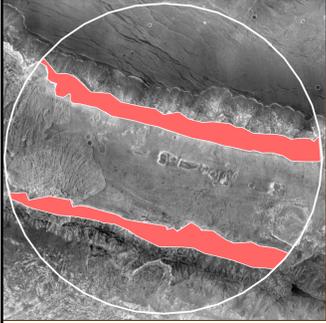
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CTX NASA/JPL/ASU/MSSS

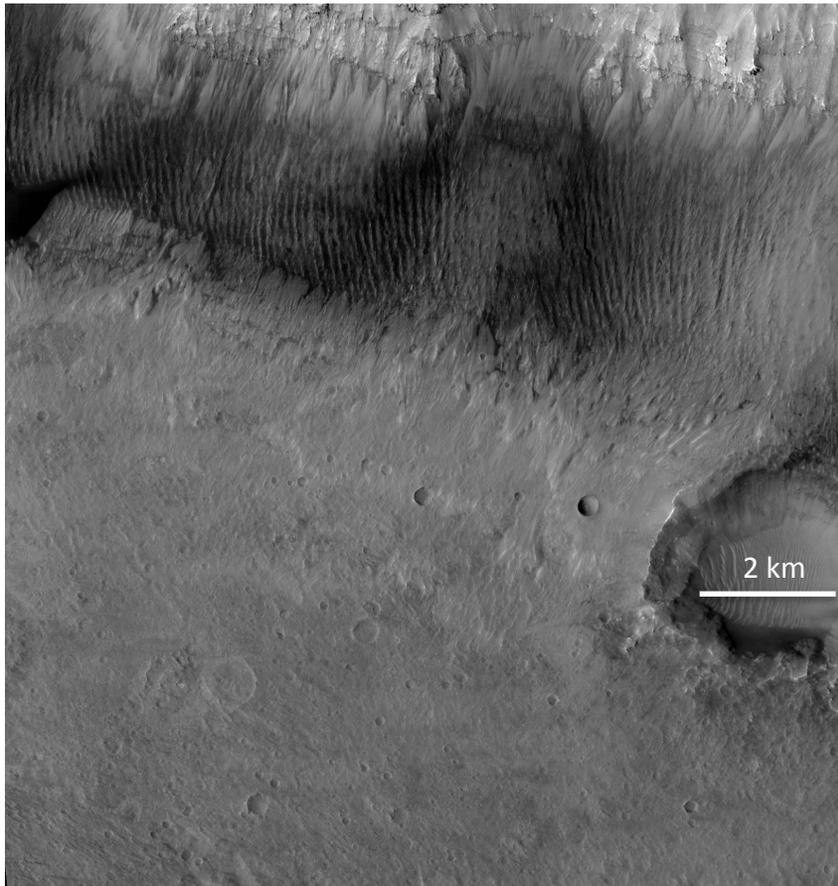
- Confirmed and accessible RSLs!
 - McEwen et al. 2014
- Another great site to search for extant life
- Impact glass
- Exposed basin stratigraphy

Central Peak: 294.738°E, -12.395°N



RROI 1 & 2 - Feedstock

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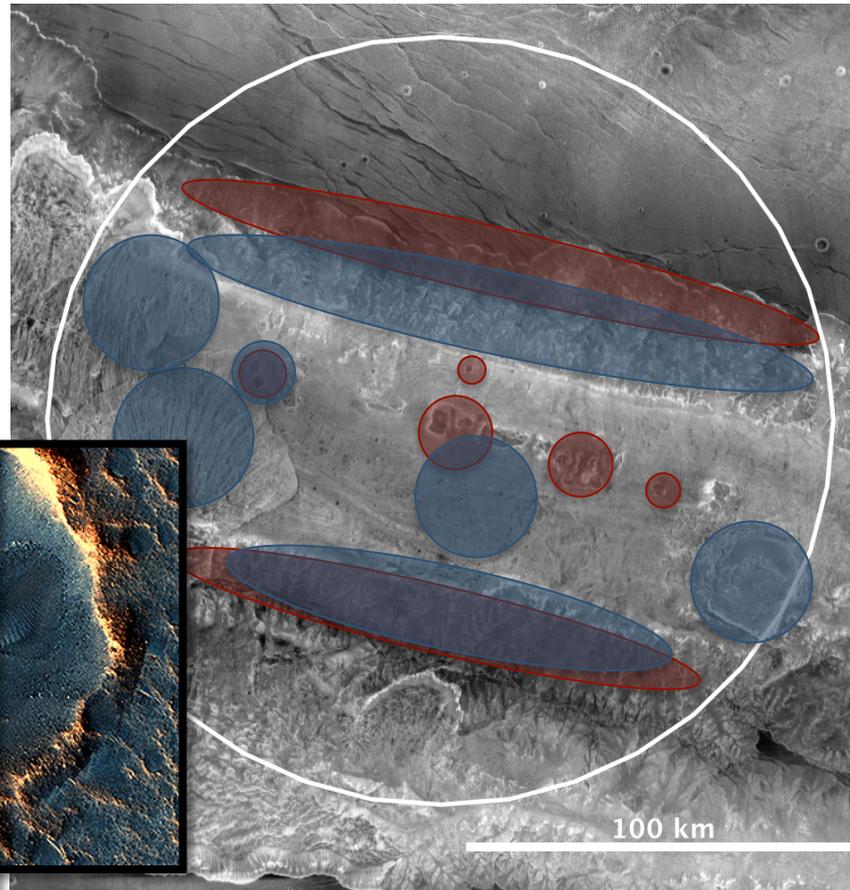
HiRISE NASA/JPL/ASU/MSSS

- Mass wasted feedstock material from the valley walls
 - Basalt
 - Olivine
 - Clay materials
 - Iron, Magnesium
 - Silicon

North Wall: 293.438°E, -11.285°N
South Wall: 293.230°E, -12.438°N

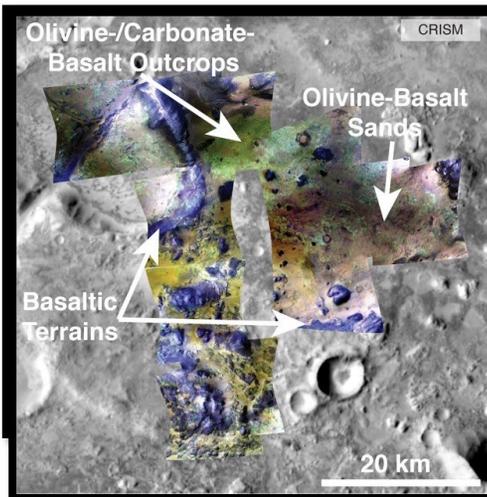
Highest Priority Data Needs

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HiRISE – High Resolution Imaging Science Experiment
0.3 m/pixel

CRISM – Compact Reconnaissance Imaging Spectrometer for Mars
0.362-3.92 $\mu\text{m } \lambda$
0.7-1000 $\mu\text{m } \lambda$



Acknowledgments

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Christopher E. Carr

Maria T. Zuber

Jacopo Tani

Aditya Bhattacharya

Peter Breen

Gary Ruvkun



MATISSE NNX15AF85G

Thank You

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293.440°E,
-11.760°N

Altitude: -4.8km

Legend:

SROI: Science
Region of Interest

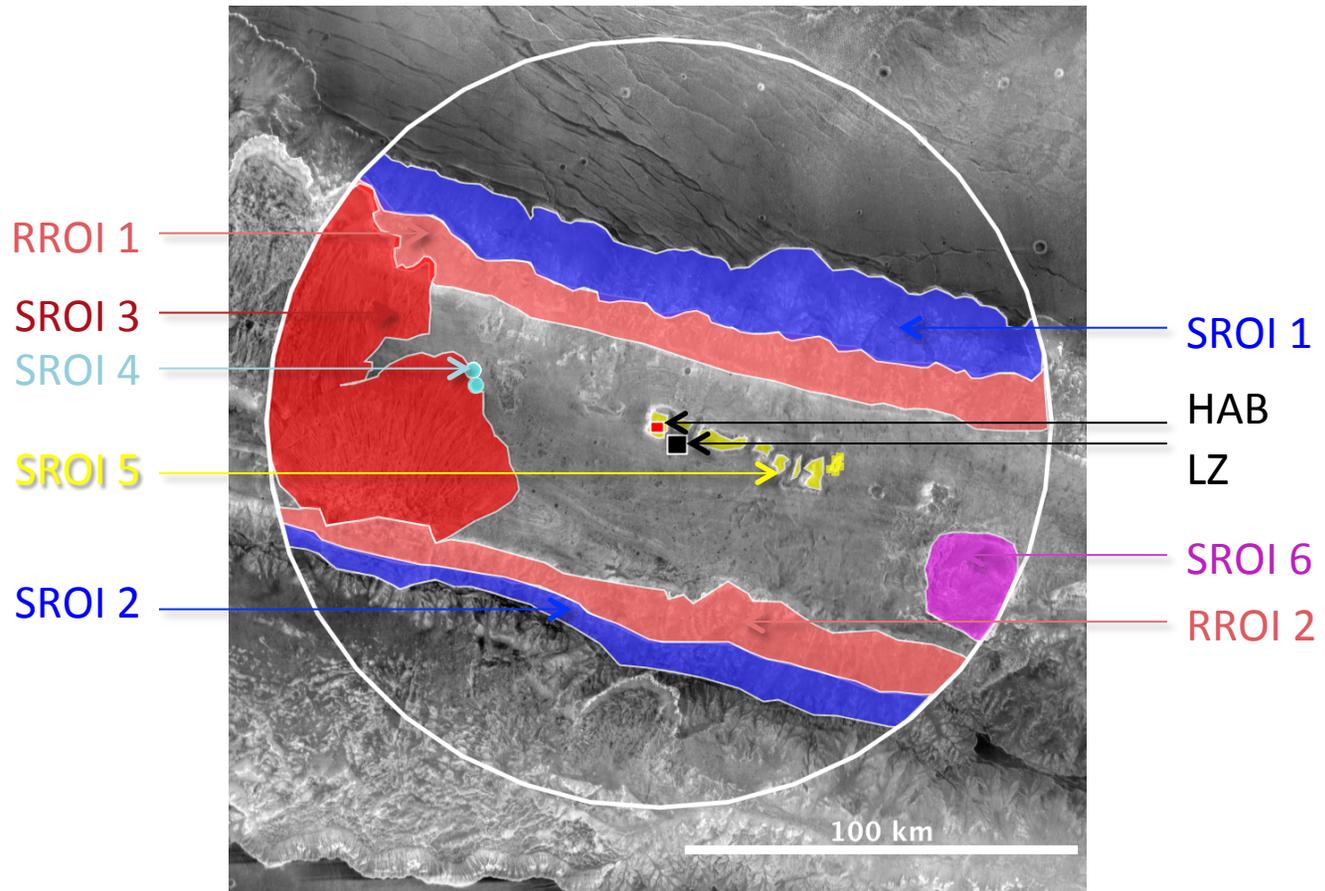
RROI: Resource
Region of Interest

HAB: Habitation
Zone

LZ: Landing Zone

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Science ROI(s) Rubric

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		Qualifying	High likelihood of surface-atmosphere exchange								5,0	
			Amazonian subsurface or high-latitude ice or sediment								5,0	
			High likelihood of active trace gas sources								0,0	
			Range of martian geologic time; datable surfaces								8,0	
			Evidence of aqueous processes								8,0	
	Potential for interpreting relative ages								8,0			
	Geoscience	Qualifying	Igneous Rocks tied to 1+ provinces or different times								7,0	
			Near-surface ice, glacial or permafrost								7,0	
			Noachian or pre-Noachian bedrock units								7,0	
Outcrops with remnant magnetization								5,2				
Primary, secondary, and basin-forming impact deposits								3,0				
Structural features with regional or global context								6,0				
Diversity of aeolian sediments and/or landforms								8,0				

Key	
●	Yes
○	Partial Support or Debated
	No
?	Indeterminate

Resource ROI(s) Rubric

1st EZ Workshop for Human Missions to Mars

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			Located less than 3 km from processing equipment site											
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		Qualifying	Potential for multiple sources of ice, ice/regolith mix and hydrated minerals											
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			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														
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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

Landing Site meets all requirements