Equatorial Opportunities for Humans on Mars

#1023

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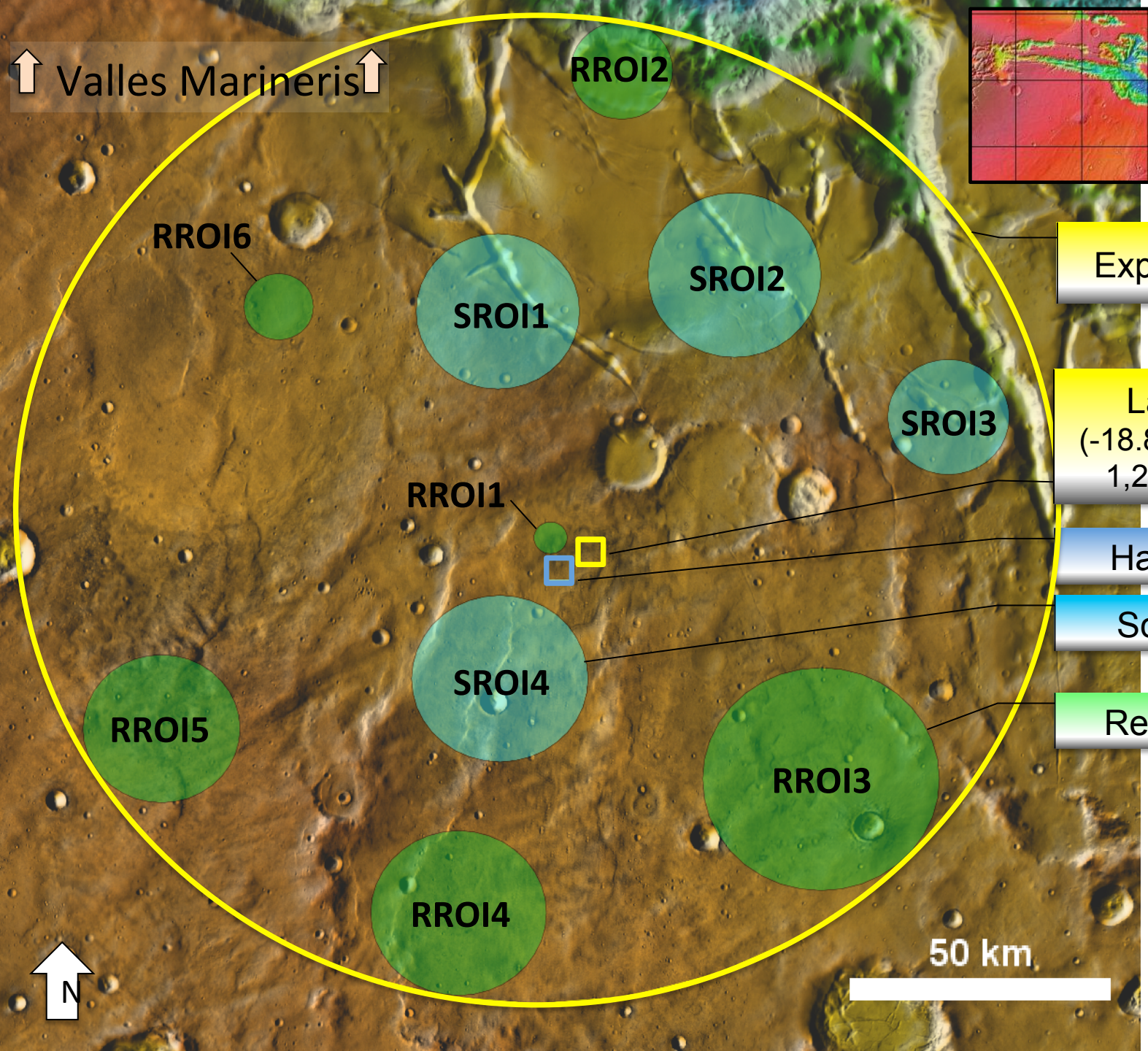
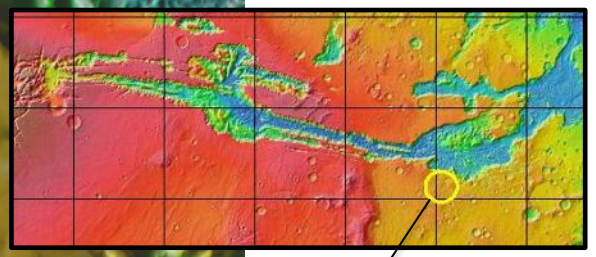
JMARS

MARS Space Flight Facility





Exploration Zone

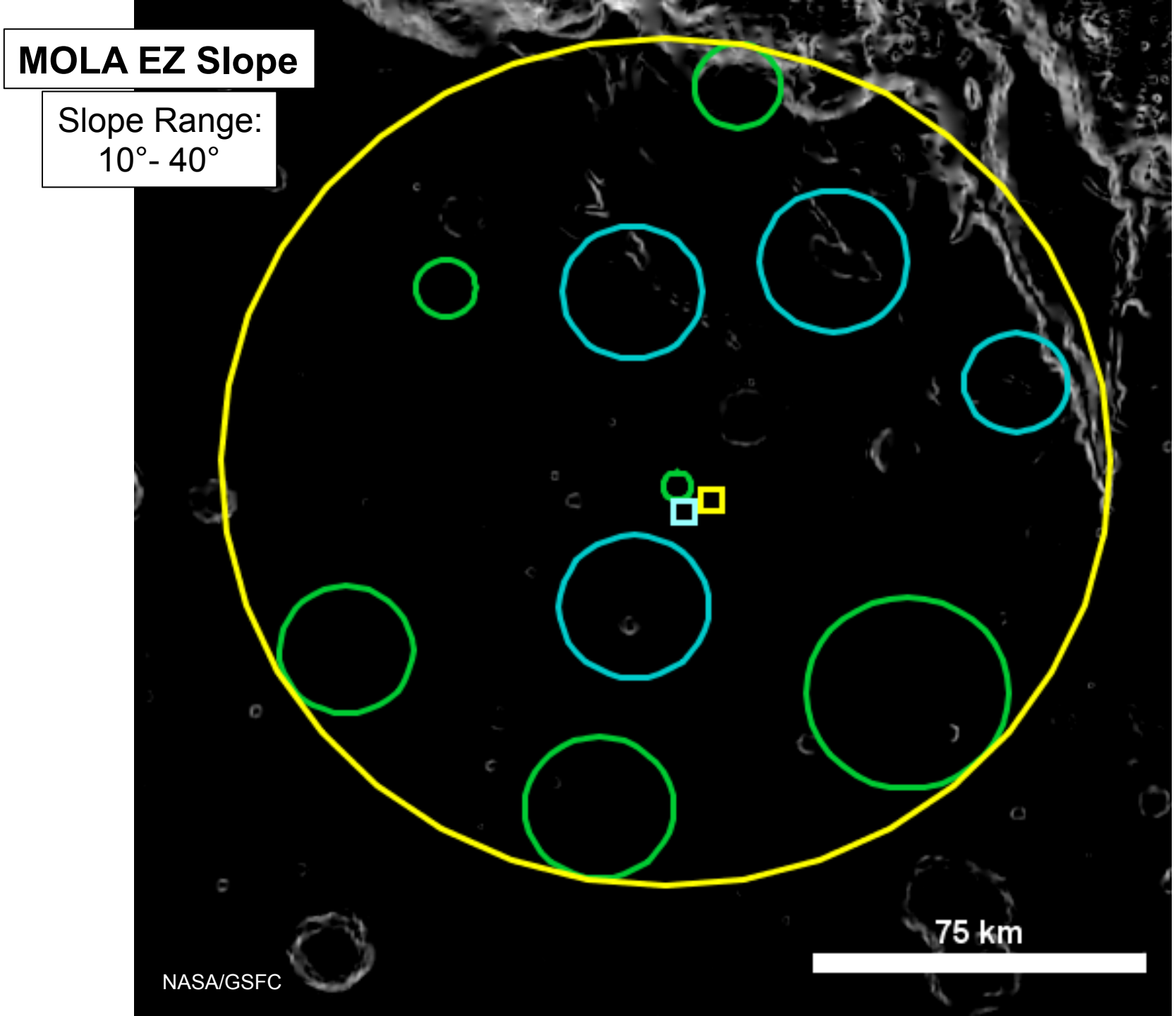
Landing Site
(-18.83°N, 310.79°E)
1,200m elevation

Habitation Site

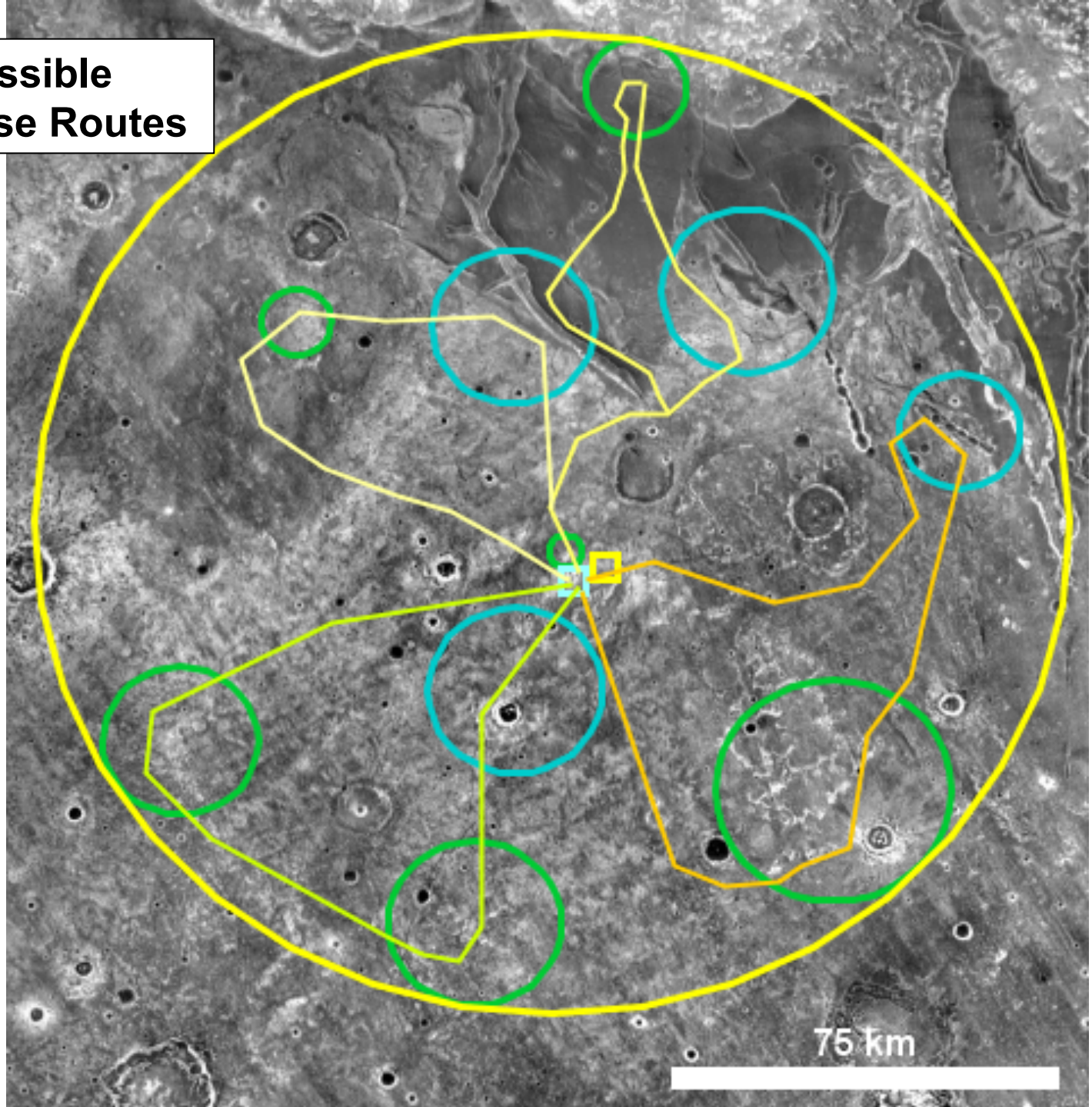
Science ROIs

Resource ROIs

MOLA Colorized Elevation (top, NASA/ GSFC) on THEMIS Day IR (NASA/ASU).

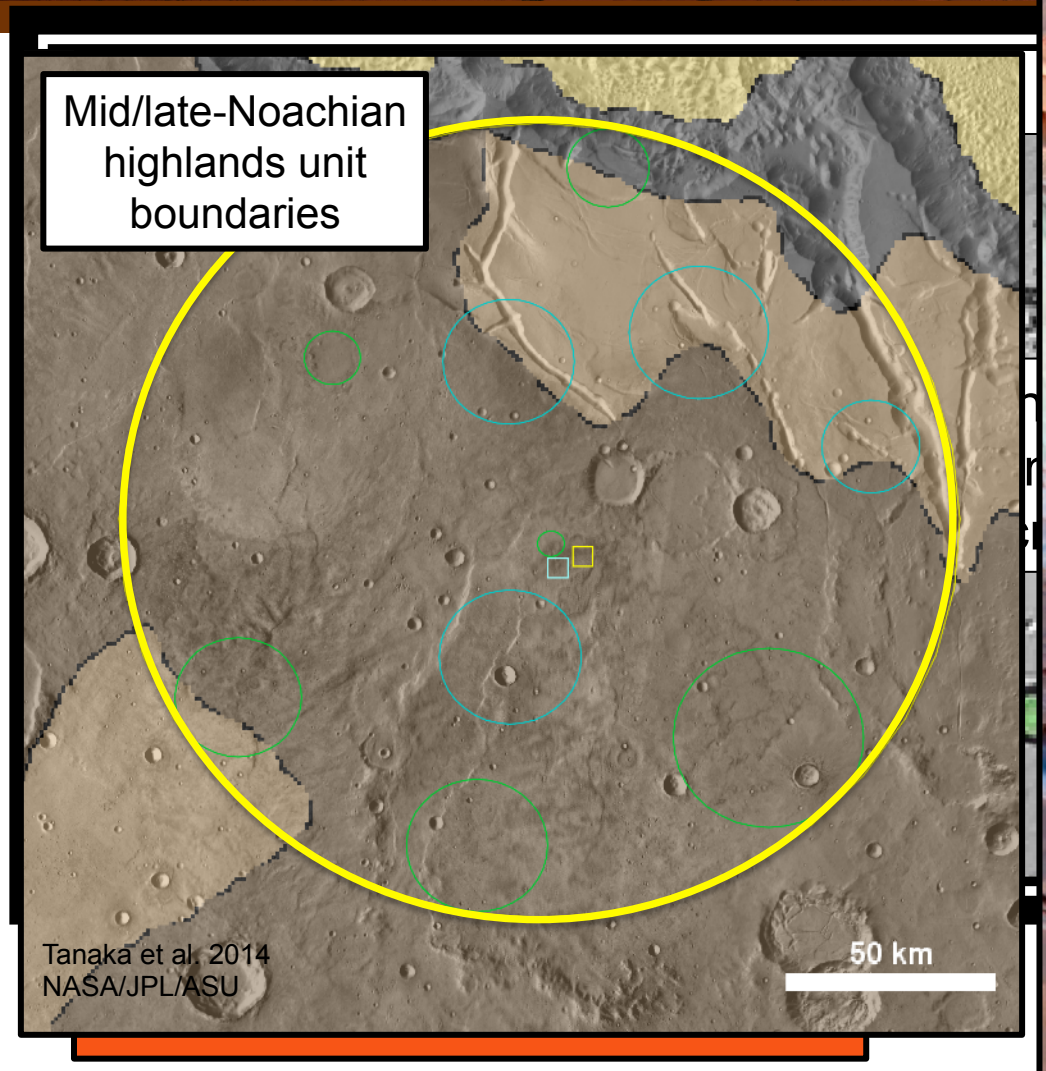

MOLA EZ Slope
Slope Range:
10°- 40°
75 km
NASA/GSFC

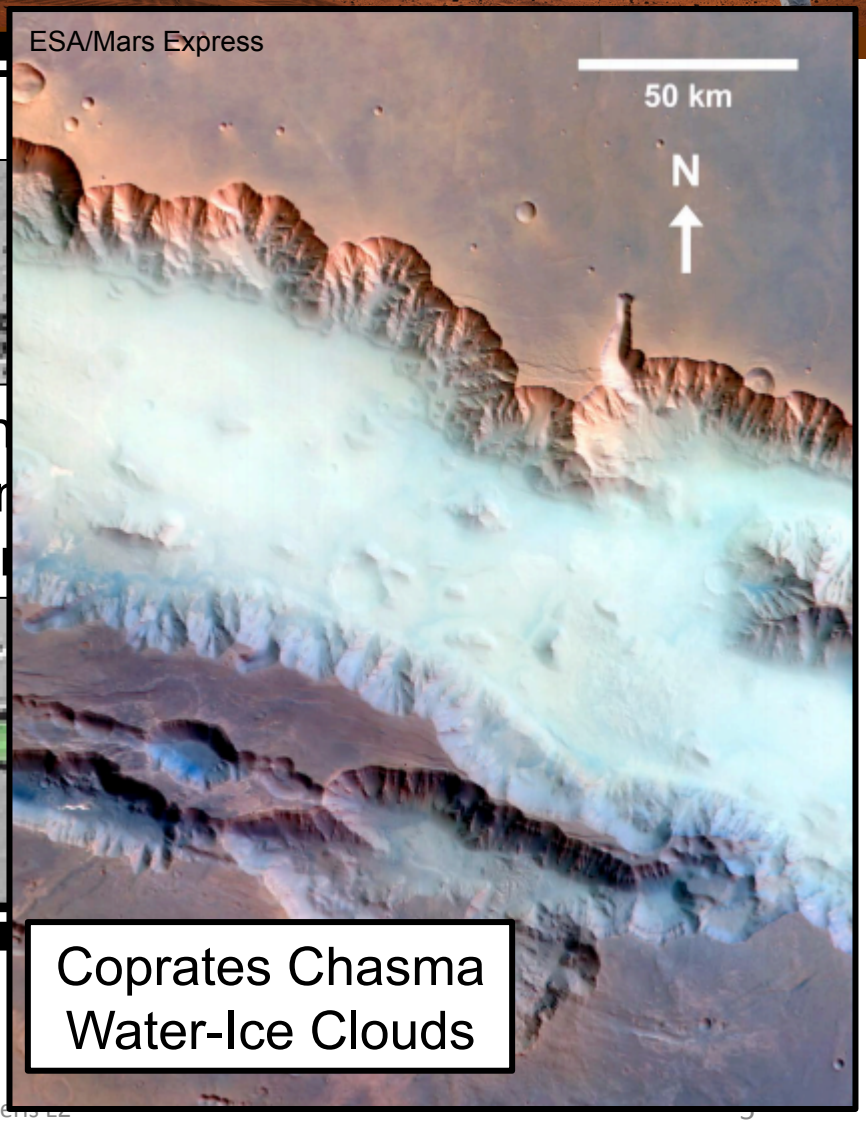
Possible Traverse Routes



NASA/JPL/ASU

EZ-Wide Science & Resources





RUBRICS

Science ROIs Rubric

1st EZ Workshop for Human Missions to Mars

Science Site Criteria				Site Factors	SROI1	SROI2	SROI3	SROI4	RROI1	RROI2	RROI3	RROI4	RROI5	RROI6	EZ SUM
	Astrobio	Threshold	AND/OR	**Potential for past habitability**	●	●	●		●	●		●	●	?	7,0
				Potential for present habitability/refugia					○	○	○	○			0,3
		Qualifying		Potential for organic matter, w/ surface exposure											0,0
	Atmospheric Science	Threshold		**Noachian/Hesperian rocks w/ trapped atmospheric gases**	?	?	?	?	?	?	?	?	?	?	0,0
		Qualifying		Meteorological diversity in space and time	○	○	○	○	○	○	○	○	○	○	10,0
				High likelihood of surface-atmosphere exchange					●	●		●			3,0
				Amazonian subsurface or high-latitude ice or sediment											0,0
				High likelihood of active trace gas sources	?	?	?	?	?	?	?	?	?	?	0,0
	Geoscience	Threshold		**Range of martian geologic time; datable surfaces**	●	●	●			●			●		4,0
				Evidence of aqueous processes	●	●	●	○	●	○	●	●	●	?	7,2
				Potential for interpreting relative ages	●	●	●			●			●		4,0
		Qualifying		Igneous Rocks tied to 1+ provinces or different times	●	●	●						●		4,0
				Near-surface ice, glacial or permafrost											0,0
				Noachian or pre-Noachian bedrock units	●	●	●	●	●	?	●	●	●	●	9,0
				Outcrops with remnant magnetization	●		●	●	●	●	●	●	●	●	9,0
				Primary, secondary, and basin-forming impact deposits	●	●		●	●		●				0,0
				Structural features with regional or global context	●	●	●	●	?	●	?	●	?	?	6,0
				Diversity of aeolian sediments and/or landforms	○	○	○	○	○	○	○	○	○	○	10,0

Key	
●	Yes
○	Partial Support or Debated
	No
?	Indeterminate

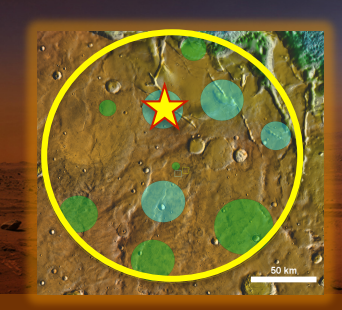
Resource ROIs Rubric

1st EZ Workshop for Human Missions to Mars

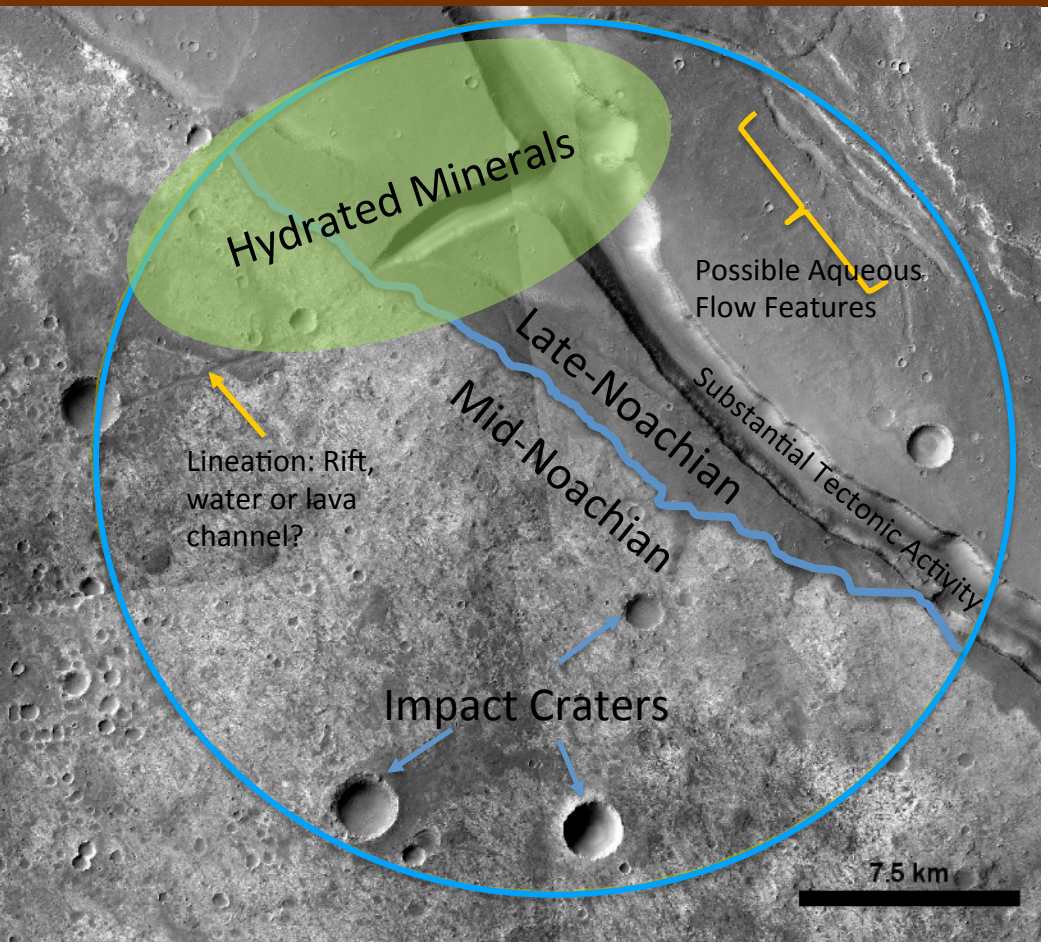
ISRU and Civil Engineering Criteria		Site Factors	SROI1	SROI2	SROI3	SROI4	RROI1	RROI2	RROI3	RROI4	RROI5	RROI6	EZ SUM
Engineering		Meets First Order Criteria (Latitude, Elevation, Thermal Inertia)	●	●	●	●	●	●	●	●	●	●	(10,0)
Water Resource	Threshold	Potential for ice or ice/regolith mix											(0,0)
		AND/OR											
		Potential for hydrated minerals	●	●	●		●	○	●	●	●		(7,1)
		Quantity for substantial production					●			●			(2,0)
		Potential to be minable by highly automated systems	●	●	●		●	●	●	●	●		(8,0)
		Located less than 3 km from processing equipment site					●						(1,0)
		Located no more than 3 meters below the surface	●	●	●	●	●	●	●	●	●	●	(6,0)
		Accessible by automated systems	●	●	●		○	●	●	●	●		(7,1)
	Qualifying	Potential for multiple sources of ice, ice/regolith mix **and** hydrated minerals											(0,0)
		Distance to resource location can be >5 km	●	●	●			●	●	●	●		(7,0)
		Route to resource location must be (plausibly) traversable	●	●	●		●	●	●	●	●		(8,0)
Civil Engineering	Threshold	~50 sq km region of flat and stable terrain with sparse rock distribution				●	●		●	●	●	●	(6,0)
		1–10 km length scale: <10°	○	○	○	○	●		●	●	●	●	(5,4)
		Located within 5 km of landing site location					●						(1,0)
	Qualifying	Located in the northern hemisphere											(0,0)
		Evidence of abundant cobble sized or smaller rocks and bulk, loose regolith					○				○	○	(0,3)
		Utilitarian terrain features	●	●	●	●		●					(5,0)
Food Production	Qualifying	Low latitude	●	●	●	●	●	●	●	●	●	●	(10,0)
		No local terrain feature(s) that could shadow light collection facilities				●	●		●	●	●	●	(6,0)
		Access to water	●	●	●		●	○	●	●	●		(7,1)
		Access to dark, minimally altered basaltic sands										●	(1,0)
Metal/Silicon Resource	Threshold	Potential for metal/silicon											(0,0)
		Potential to be minable by highly automated systems			●	●		●		●	●	●	(4,0)
		Located less than 3 km from processing equipment site											(0,0)
		Located no more than 3 meters below the surface			●	●		●		●	●	●	(4,0)
		Accessible by automated systems			●	●		●		●	●	●	(4,0)
	Qualifying	Potential for multiple sources of metals/silicon				●		●		●	●	●	(1,0)
		Distance to resource location can be >5 km			●	●		●		●	●	●	(4,0)
		Route to resource location must be (plausibly) traversable			●	●		●		●	●	●	(4,0)

Key	
●	Yes
○	Partial Support or Debated
	No
?	Indet.


SCIENCE ROIs



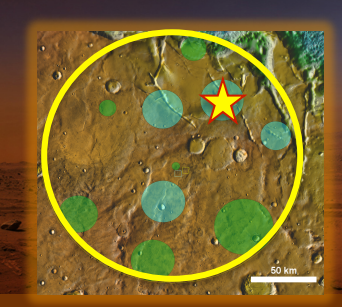
Science ROI 1



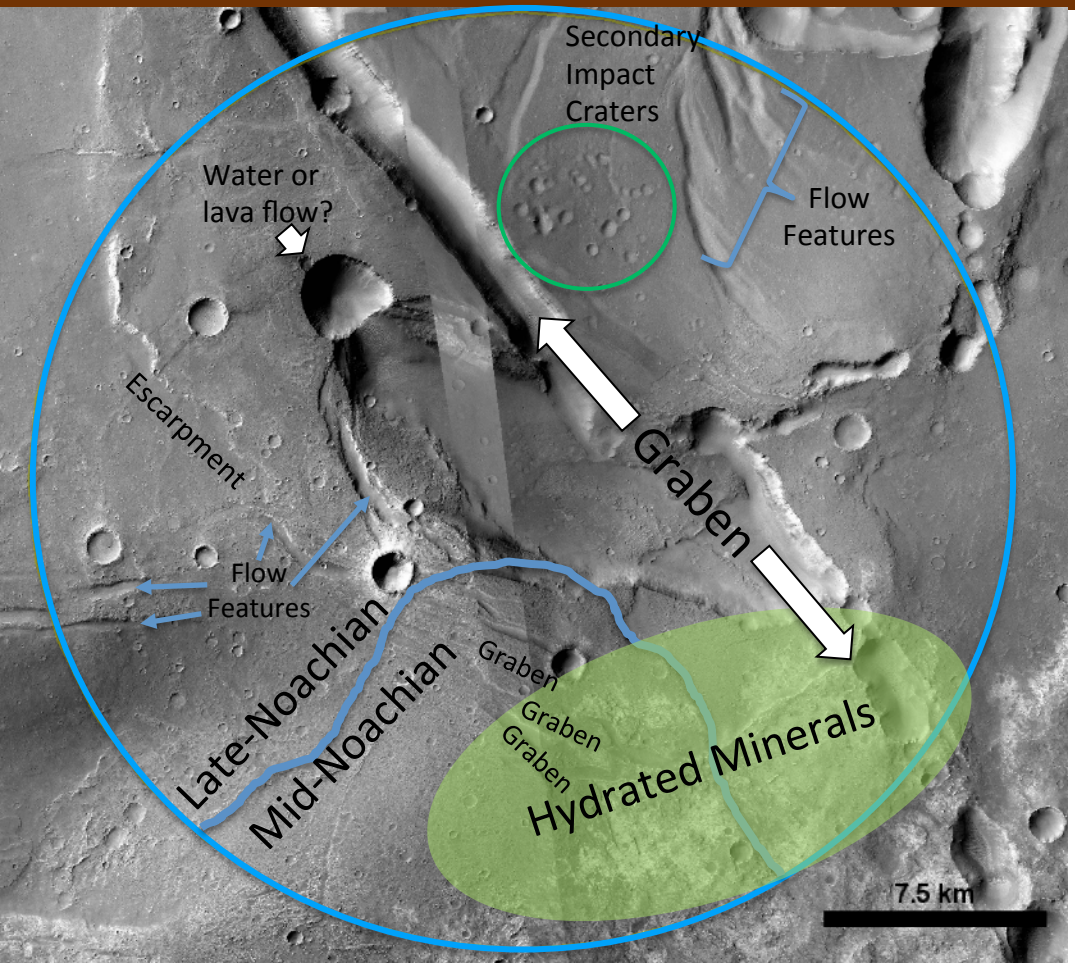
CTX basemap (NASA/JPL-Caltech/MSSS). Hydrated minerals from OMEGA (ESA/CNES/CNRS/IAS/ Université Paris-Sud, Orsay). Geologic contact from Tanaka et al., 2015.

Coordinates: (-18.00°N, 310.48°E)
Elevation: 1,200m

- Coverage:
  - Full CTX
  - Partial HRSC/CRISM
  - No HiRISE
- Primary Science Opportunities:
  - mNh/lNh contact
  - Hydrated minerals
  - Study of global tectonic process (VM formation)
  - Aqueous geomorphology
  - Impact crater processes



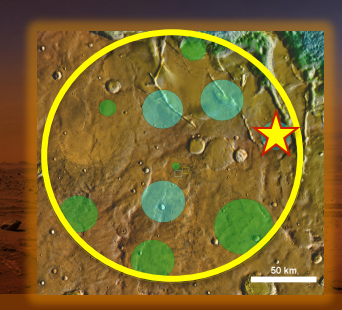
Science ROI 2



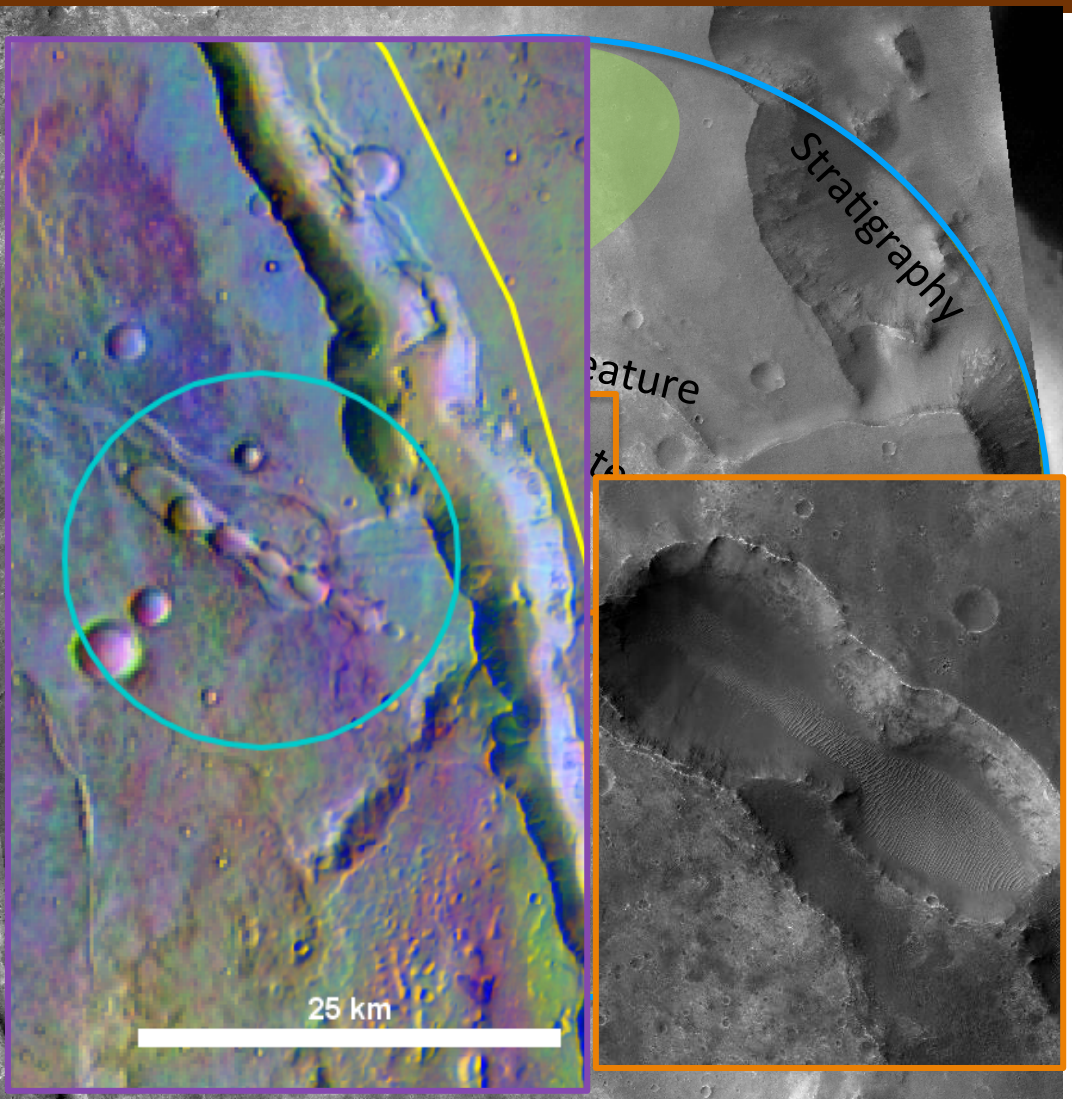
CTX basemap (NASA/JPL-Caltech/MSSS). Hydrated minerals from OMEGA (ESA/CNES/CNRS/IAS/ Université Paris-Sud, Orsay). Geologic contact from Tanaka et al., 2015.

Coordinates: (-17.87°N, 311.29°E)
Elevation: 650m

- Coverage:
  - Full CTX
  - Partial HRSC/HiRISE
  - No CRISM
- Primary Science Opportunities:
  - Eruption event in NW quadrant
  - Study of global tectonic process (VM formation)
  - Impact crater processes, including possible secondaries
  - Aqueous geomorphology
  - mNh/lNh contact
  - Hydrated minerals



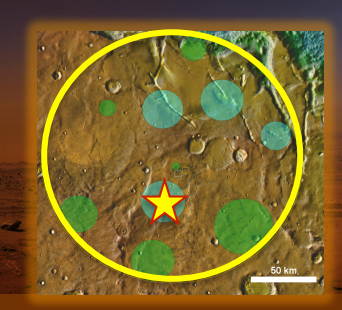
Science ROI 3



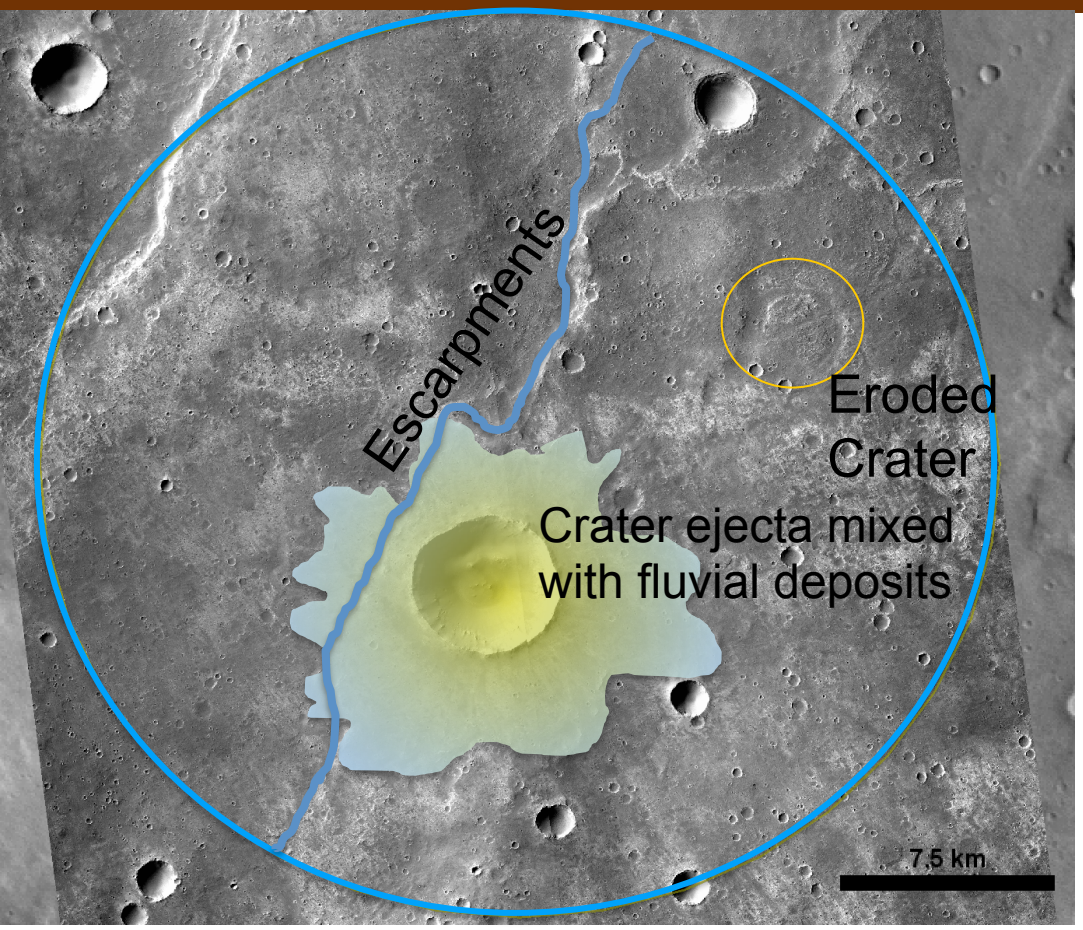
Coordinates: (-18.34°N, 312.01°E)
Elevation: 1,180m

- Coverage:
  - Full CTX
  - Partial HRSC/CRISM/ HiRISE
- Science Opportunities:
  - Pit crater chain: volcanic or tectonic process?
  - Olivine deposits
  - Tharsis stratigraphy
  - Flow features in lNh unit
  - lNh/mNh unit transition
  - Hydrated minerals
  - Impact crater processes

CTX basemap (NASA/JPL-Caltech/MSSS). Hydrated mins - OMEGA (ESA/CNES/CNRS/IAS/Université Paris-Sud, Orsay). Geologic units - Tanaka et al., 2015. Olivine – THEMIS DCS/ Edwards et al., 2008). Pit chain hi-res- HiRISE (NASA/JPL/UA).



Science ROI 4

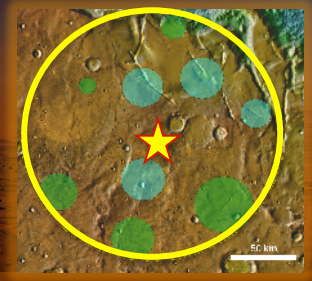


CTX basemap (NASA/JPL-Caltech/MSSS).

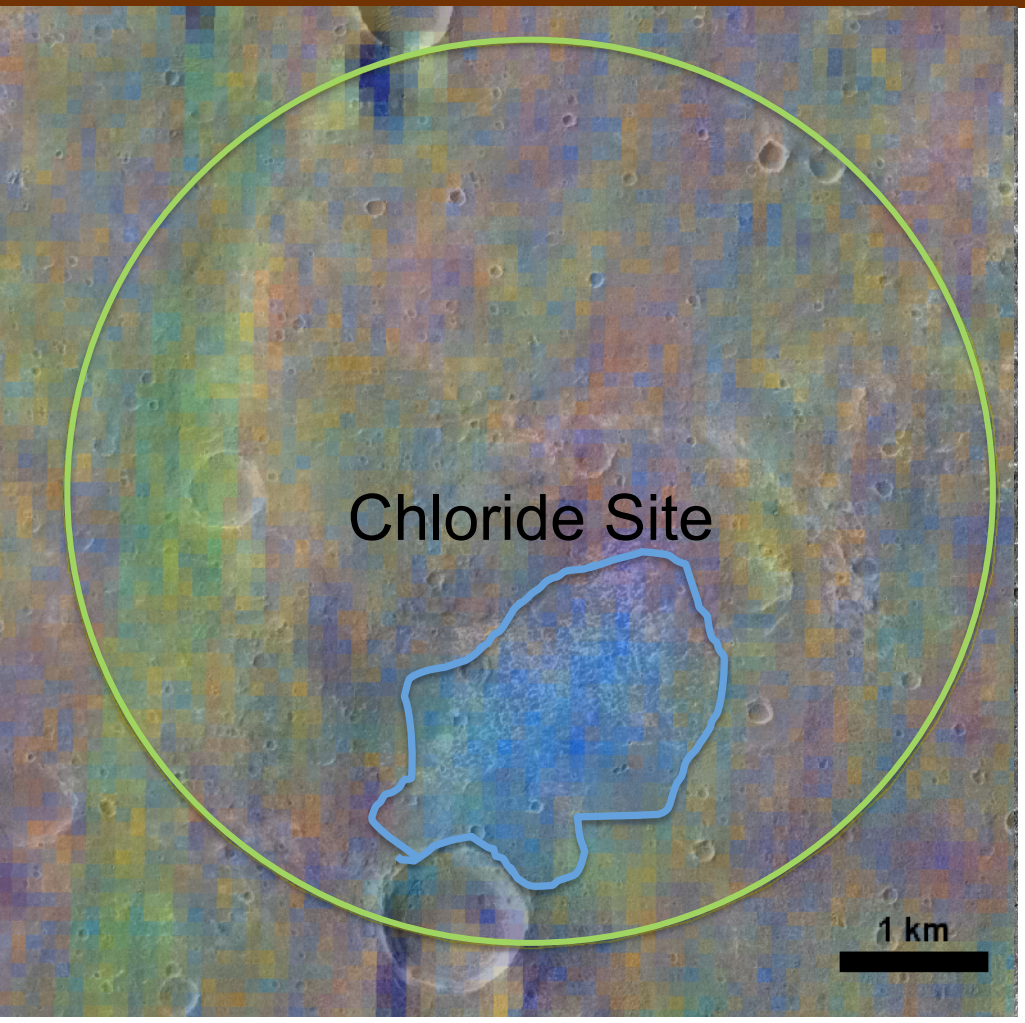
Coordinates: (-19.23°N, 310.49°E)
Elevation: 1,365m

- Coverage:
  - Full CTX/HRSC
  - Partial CRISM
  - No HiRISE
- Science Opportunities:
  - Numerous escarpments: indicative of compressional tectonics
  - Rampart crater: ancient fluvial processes

RESOURCE ROIs



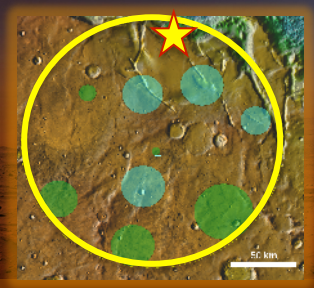
Resource ROI 1



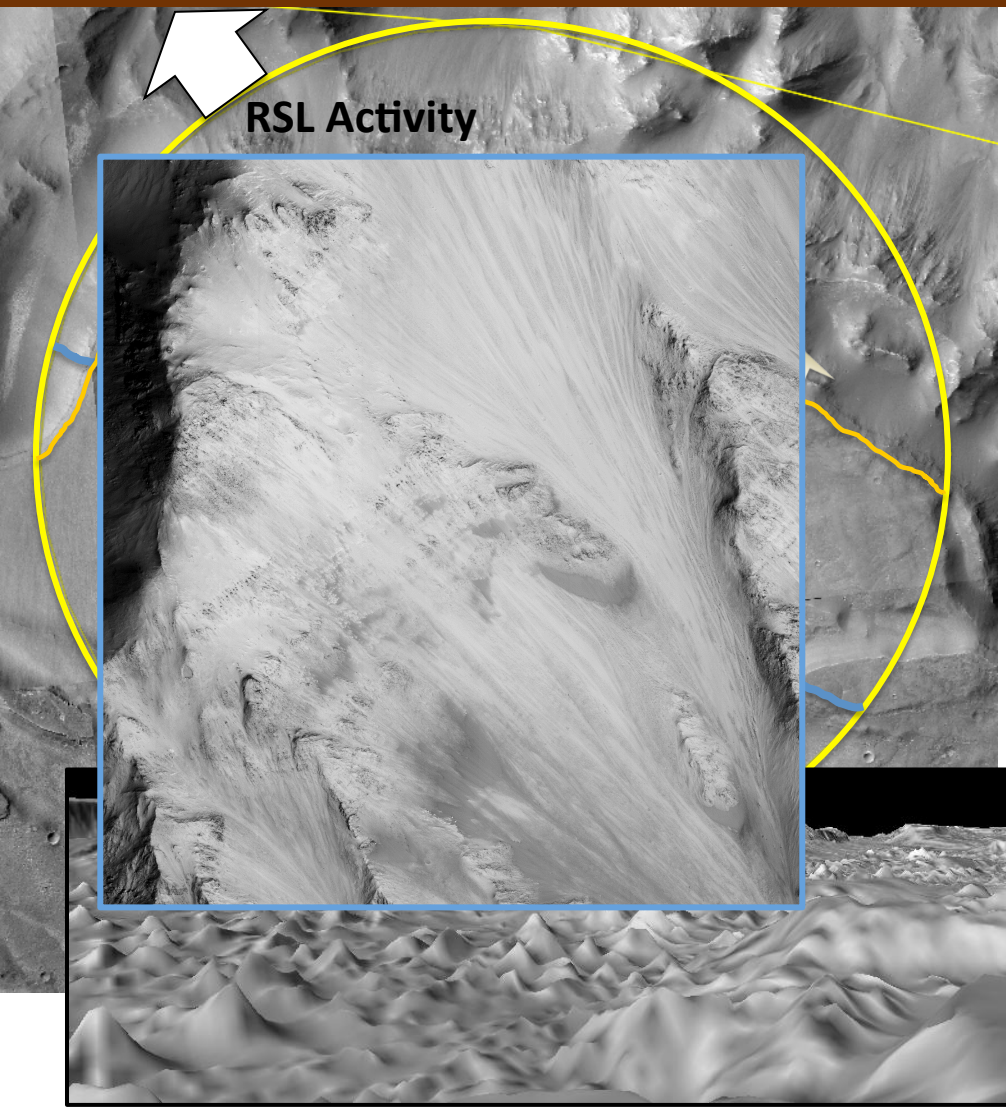
Coordinates: (-18.77°N, 310.65°E)
Elevation: 1,230m

- Coverage:
  - Full CTX/HRSC
  - No HiRISE/CRISM
- Available Resources:
  - Chloride Site
  - Building Material (dunes)

CTX basemap (NASA/JPL-Caltech/MSSS). Chloride site (THEMIS/Osterloo et al. 2008, 2010).



Resource ROI 2

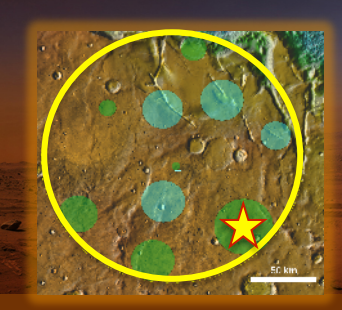


Coordinates: (-17.18°N, 310.90°E)
Elevation: 500m

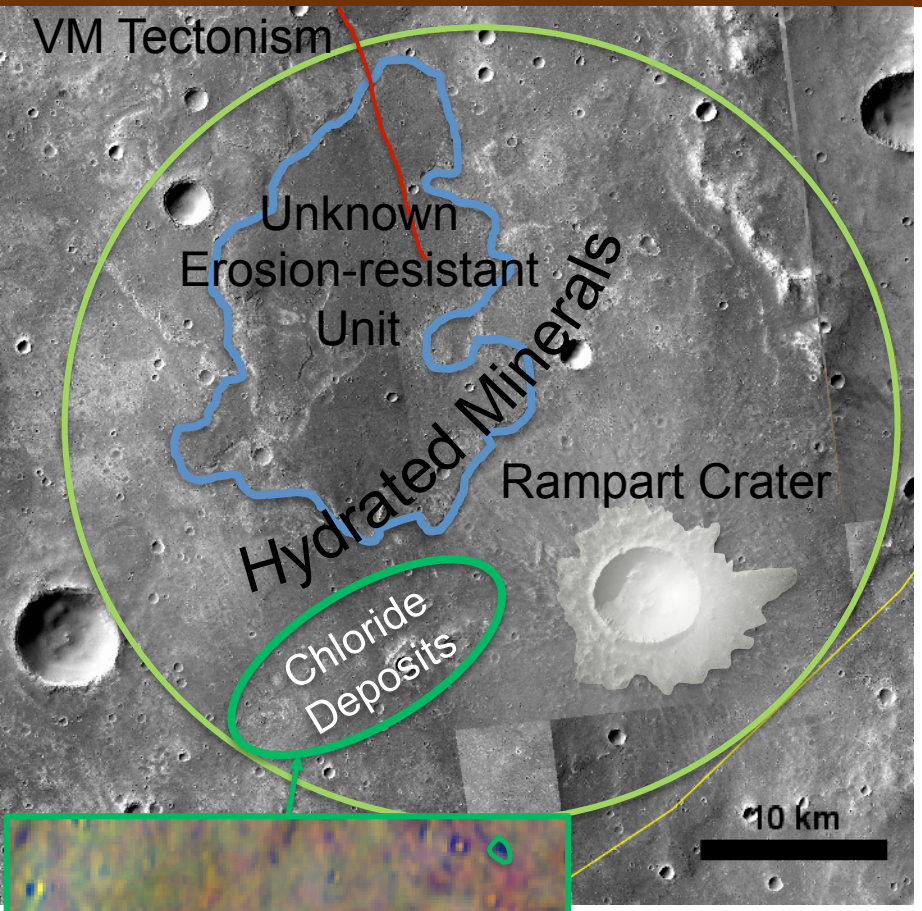
- Coverage:
  - Full CTX
  - Partial HRSC
  - No HiRISE/CRISM
- Available Resources:
  - Elevated ferric oxide and olivine throughout northern 75% of ROI (via OMEGA)
  - Proximity to active RSL in Valles Marineris

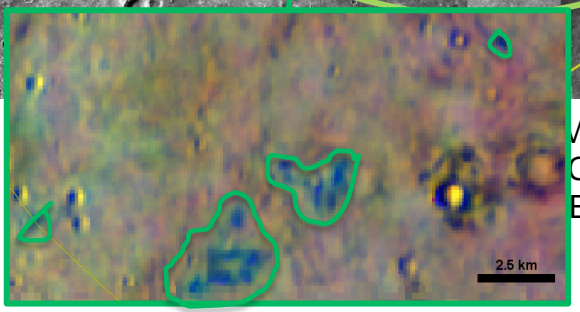
Opportunities for telerobotic ops

CTX basemap (NASA/JPL-Caltech/MSSS). Ferric oxide/olv - OMEGA (ESA/CNES/CNRS/IAS/ Université Paris-Sud, Orsay). HiRISE image (NASA/JPL/UA), RSL (McEwen et al., 2013).



Resource ROI 3

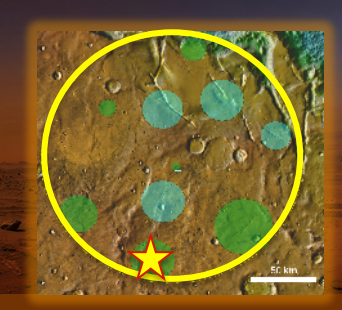




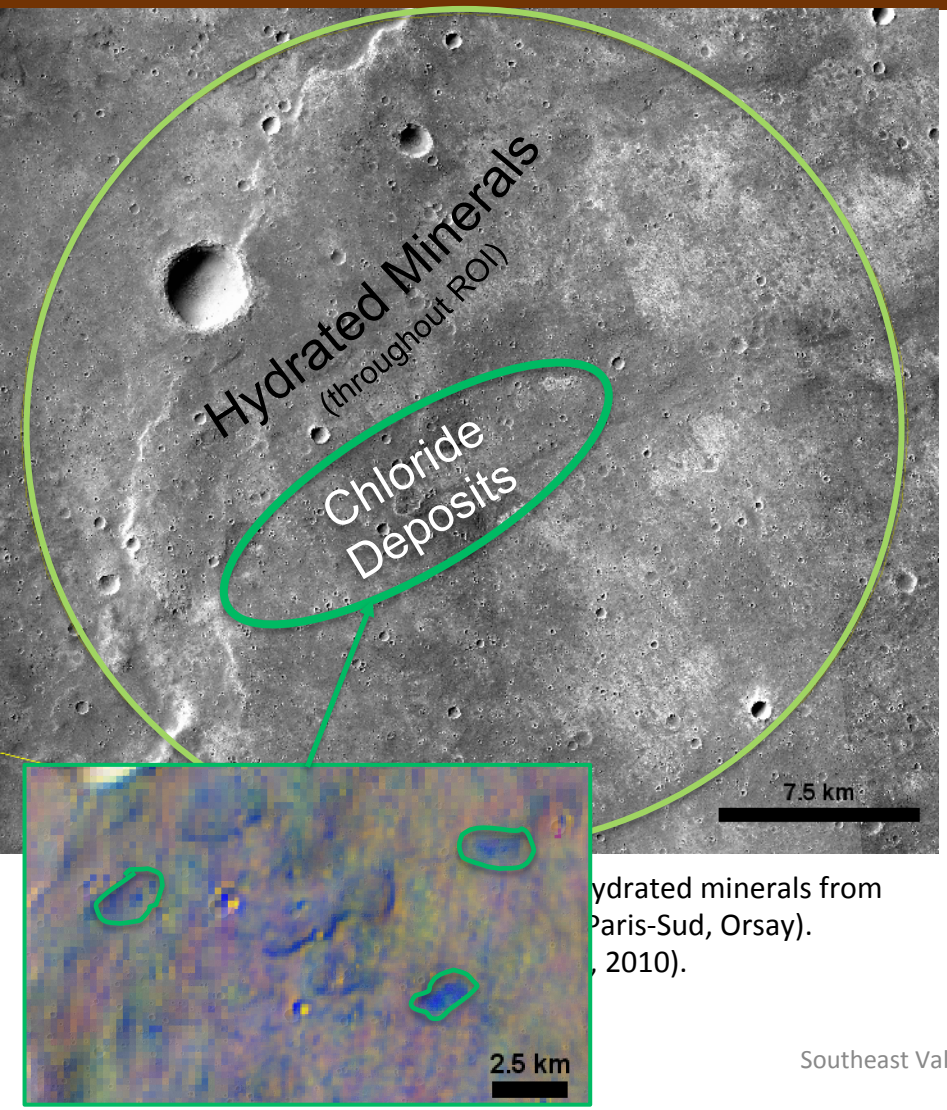
MSSS). Hydrated
CNRS/IAS/ Université
EMIS/Osterloo et al.

Coordinates: (-19.59°N, 311.58°E)
Elevation: 1,120m

- Coverage:
  - Full CTX
  - Partial HRSC/CRISM
  - No HiRISE
- Available Resources:
  - Chloride deposits
  - Hydrated minerals throughout
  - Multiple science opportunities (erosion-resistant unit, rampart crater, tectonics)



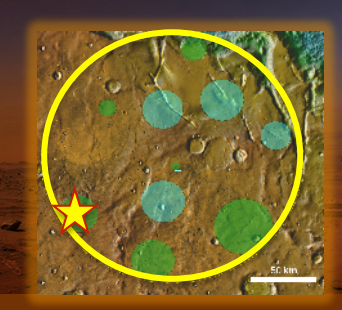
Resource ROI 4



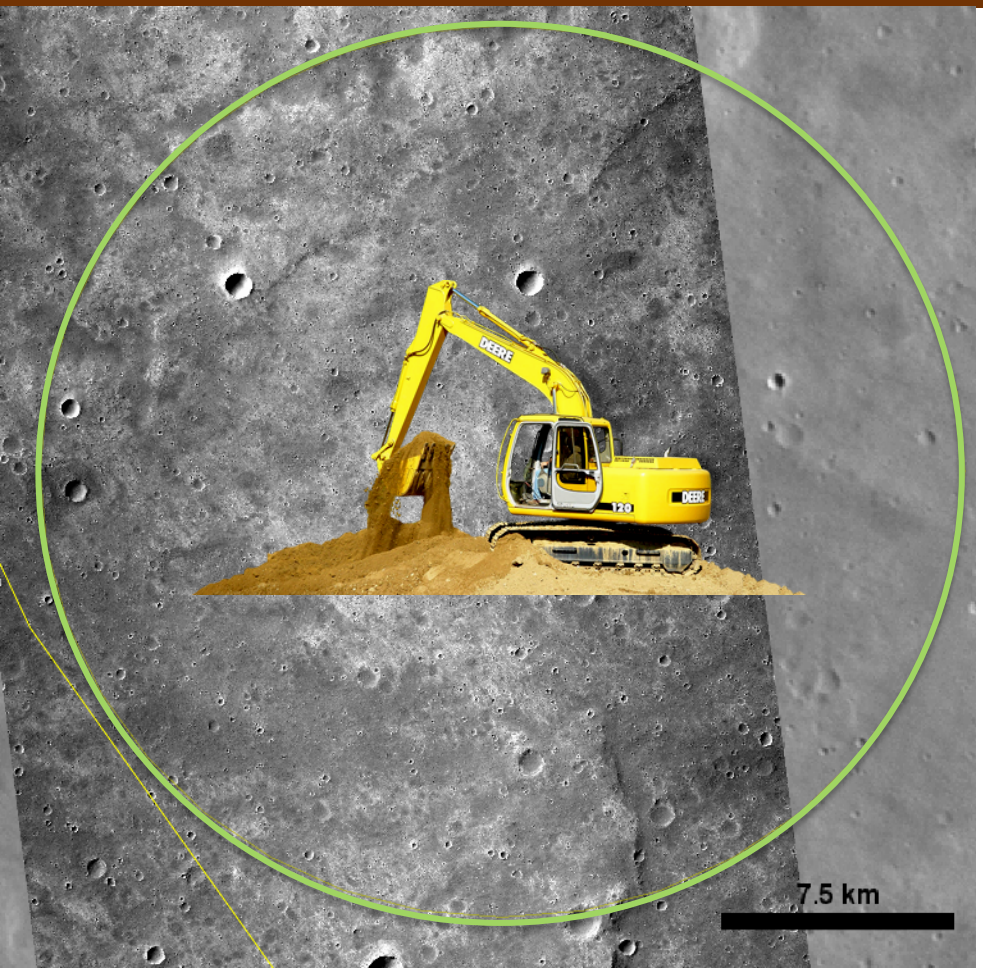
ydrated minerals from
Paris-Sud, Orsay).
, 2010).

Coordinates: (-20.02°N, 310.30°E)
Elevation: 1,440m

- Coverage:
  - Full CTX/HRSC
  - Partial CRISM
  - No HiRISE
- Available Resources:
  - Chloride deposits
  - Hydrated minerals throughout ROI



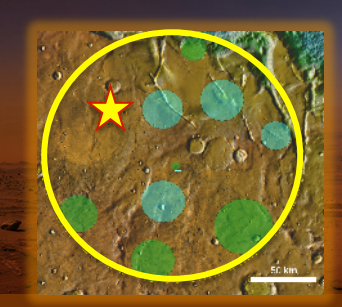
Resource ROI 5



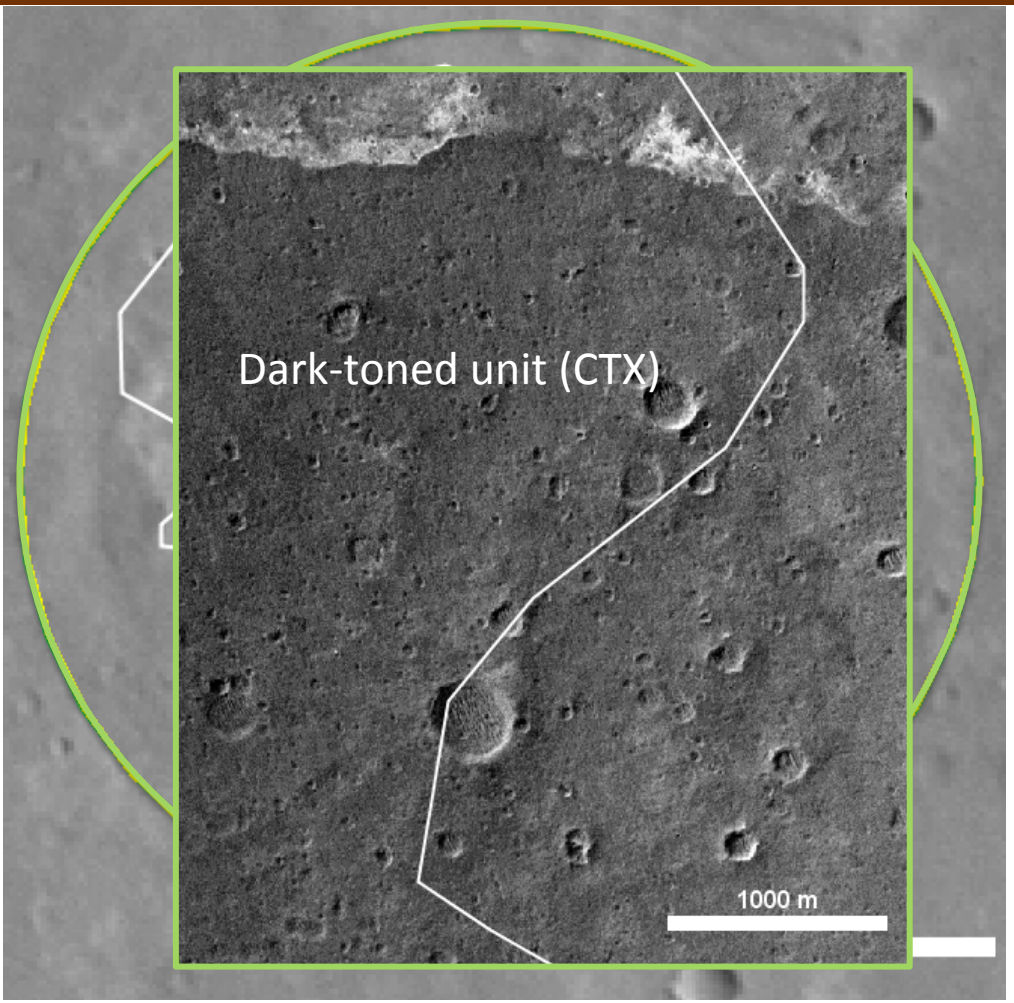
Coordinates: (-19.40°N, 309.27°E)
Elevation: 1,600m

- Coverage:
  - Partial CTX/HRSC
  - No HiRISE/CRISM
- Available Resources:
  - Hydrated minerals throughout ROI
  - Abundant sand-sized grains (based on thermal inertia)
  - Possible plagioclase-rich and high-Si phases within ROI
  - Flat terrain

CTX basemap (NASA/JPL-Caltech/MSSS). Thermal inertia – THEMIS (NASA/JPL/ASU). Mineralogy – TES (NASA/JPL/ASU).



Resource ROI 6



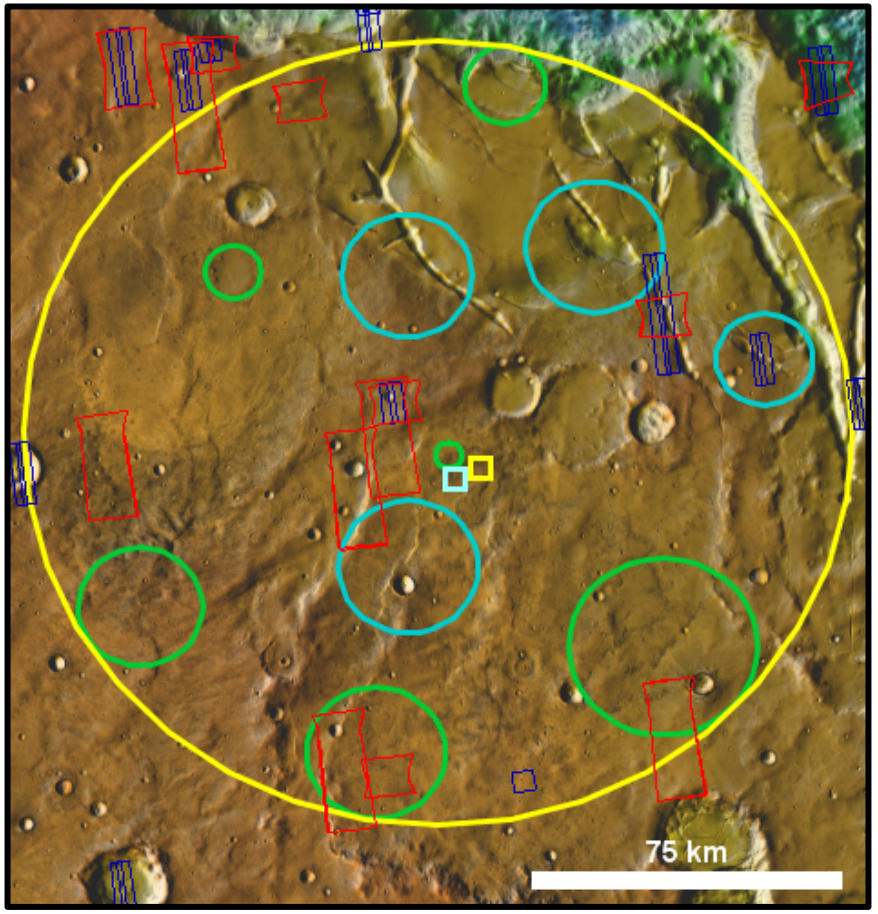
Coordinates: (-17.98°N, 309.73°E)
Elevation: 1,192m

- Coverage:
  - Full CTX/HRSC
  - No HiRISE/CRISM
- Available Resources:
  - Olivine deposit in western ROI
  - Sand-sized basalt grains throughout ROI
  - Heavily degraded crater

CTX basemap (NASA/JPL-Caltech/MSSS). Olivine and grain size (via thermal inertia) – THEMIS (NASA/JPL/ASU). Basalt – TES (NASA/JPL/ASU).

Highest Priority EZ Data Needs

1. Visible/near-infrared spectral verification of large-scale hydrated mineral deposits (CRISM FRT)
2. High-resolution imagery of landing and habitation sites (HiRISE)
3. High-spatial & spectral-resolution composition in thermal infrared (basalt, plagioclase, silica) and temperature
4. High-resolution slope for safety assessment of ROIs
5. Assessment of atmospheric water vapor



MOLA elevation (NASA/GSFC) on THEMIS Day IR (NASA/JPL/ASU).


BACK-UP
SLIDES

Prioritization List of EZ Data Needs

- Visible/near-IR spectroscopy of large-scale hydrated mineral deposits (CRISM FRT)
  - Science: To assess the extent and duration of aqueous activity on the surface and to focus crew surface investigations.
  - Resource: To quantify the amount of water available and accessible for crew use.
- High-spatial-resolution and high-spectral-resolution assessment of composition in thermal IR (basalt, plagioclase, silica) and characterization of temperatures in the region (diurnal/annual)
  - Science: To characterize the geologic distribution of volcanics, sedimentary deposits, altered materials, and other minerals in the region. To characterize the thermal variation in the region with time of day and season.
  - Resource: To find minerals that harbor metals (Mg, Fe) and silica for building purposes. To assess crew safety and hardware requirements by understanding the thermal environment in which operations will be conducted.
- High-resolution imagery of landing and habitation sites (HiRISE).
  - Science: To assist with characterization of geologic and geomorphologic sites of interest.
  - Resource: To assess the boundaries of resources (i.e. dark-toned olivine deposits).
- High-resolution slope for safety assessment of ROIs (HRSC).
- Assessment of atmospheric water vapor (MAVEN or other atmospheric science asset).
  - Science: To characterize the atmospheric environment at the martian surface.
  - Resource: To quantify the abundance of water vapor to assess its potential as a water source for crew use during surface operations.
- Rover-based exploration of chloride sites
  - Science: To confirm the chloride anion present and assess ancient hydrologic environment
  - Resource: To explore small-scale adsorbed water, phyllosilicates, and possible liquid water at depth

Valles Marineris