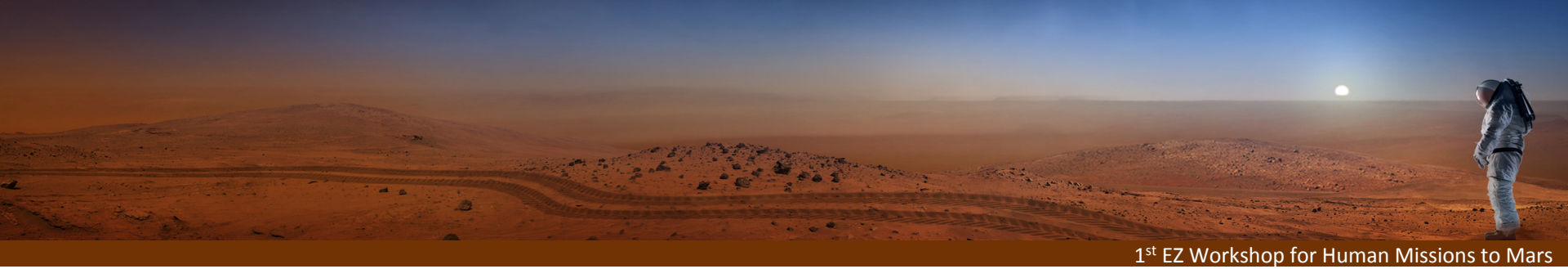

Mars Landing + 50 Years:

Repurposing the First Viking Landing Site on Chryse Planitia as an Exploration Zone for Automated Infrastructure Construction

Workshop Abstract #1019

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Department of Computational Social Sciences
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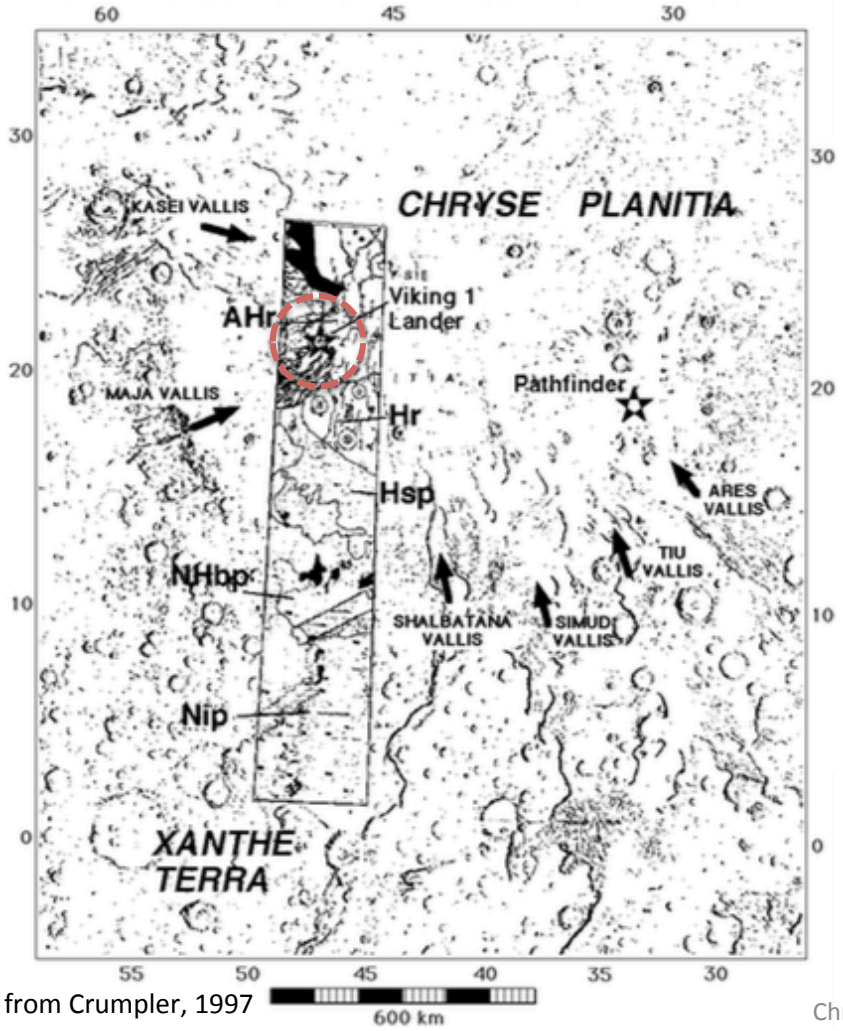
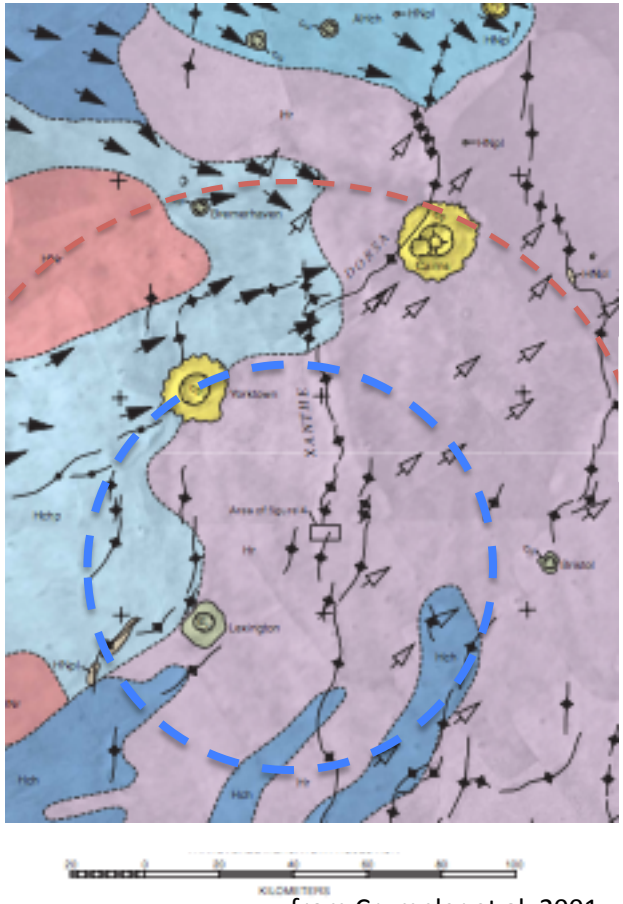
October 20, 2015

Chryse Planitia EZ Context Map



from Crumpler, 1997

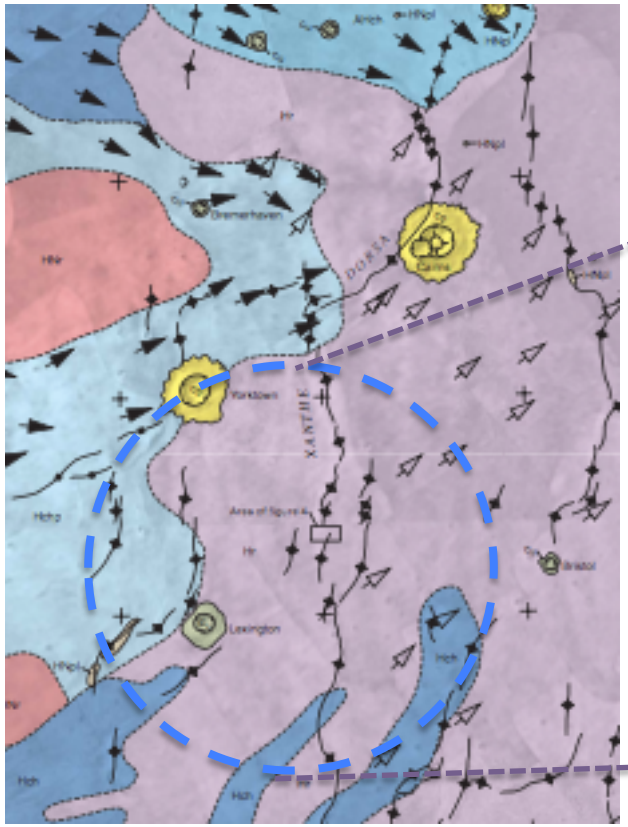
EZ Centered at latitude 22.3N, longitude 48.3W



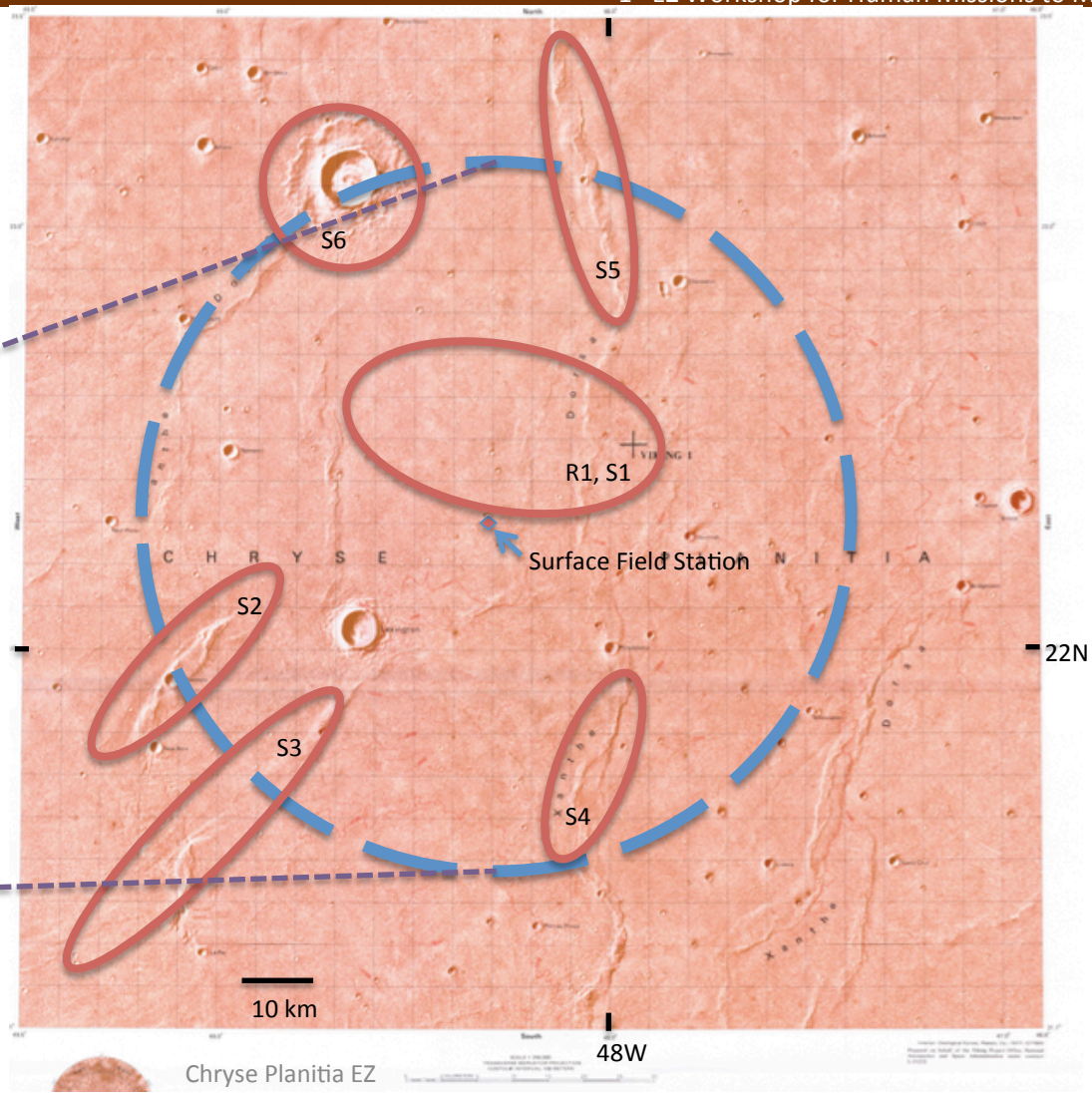
from Crumpler et al. 2001

Chryse Planitia Exploration Zone Map

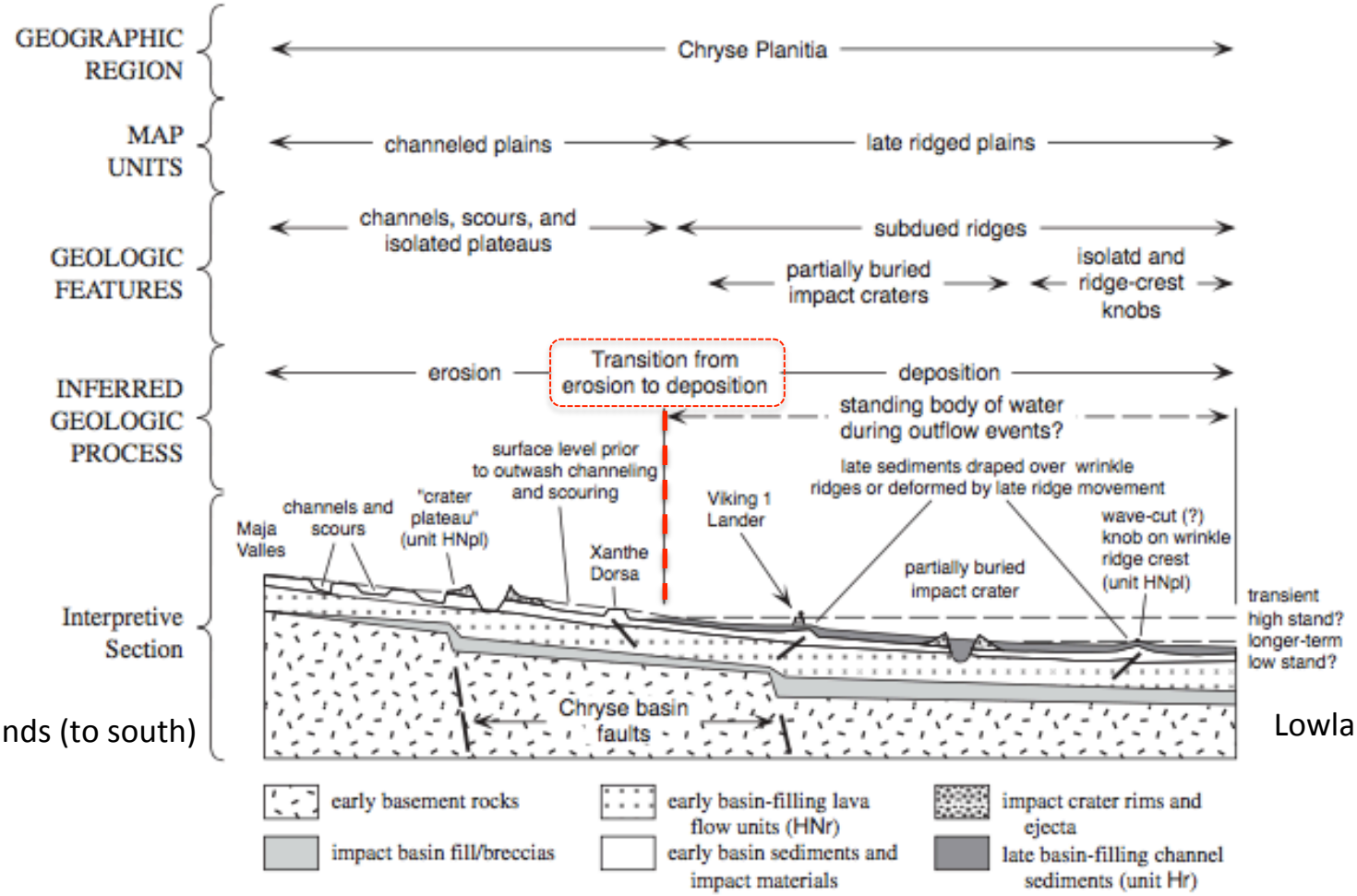
EZ Centered at latitude 22.3N, longitude 48.3W



from Crumpler et al. 2001



Context for Chryse Planitia Science ROIs



Highlands (to south)

Lowlands (to north)

From Crumpler, et al. 2001

SCIENCE ROIs

Study of VL-1 Landing Site and Vicinity (S1, R1)

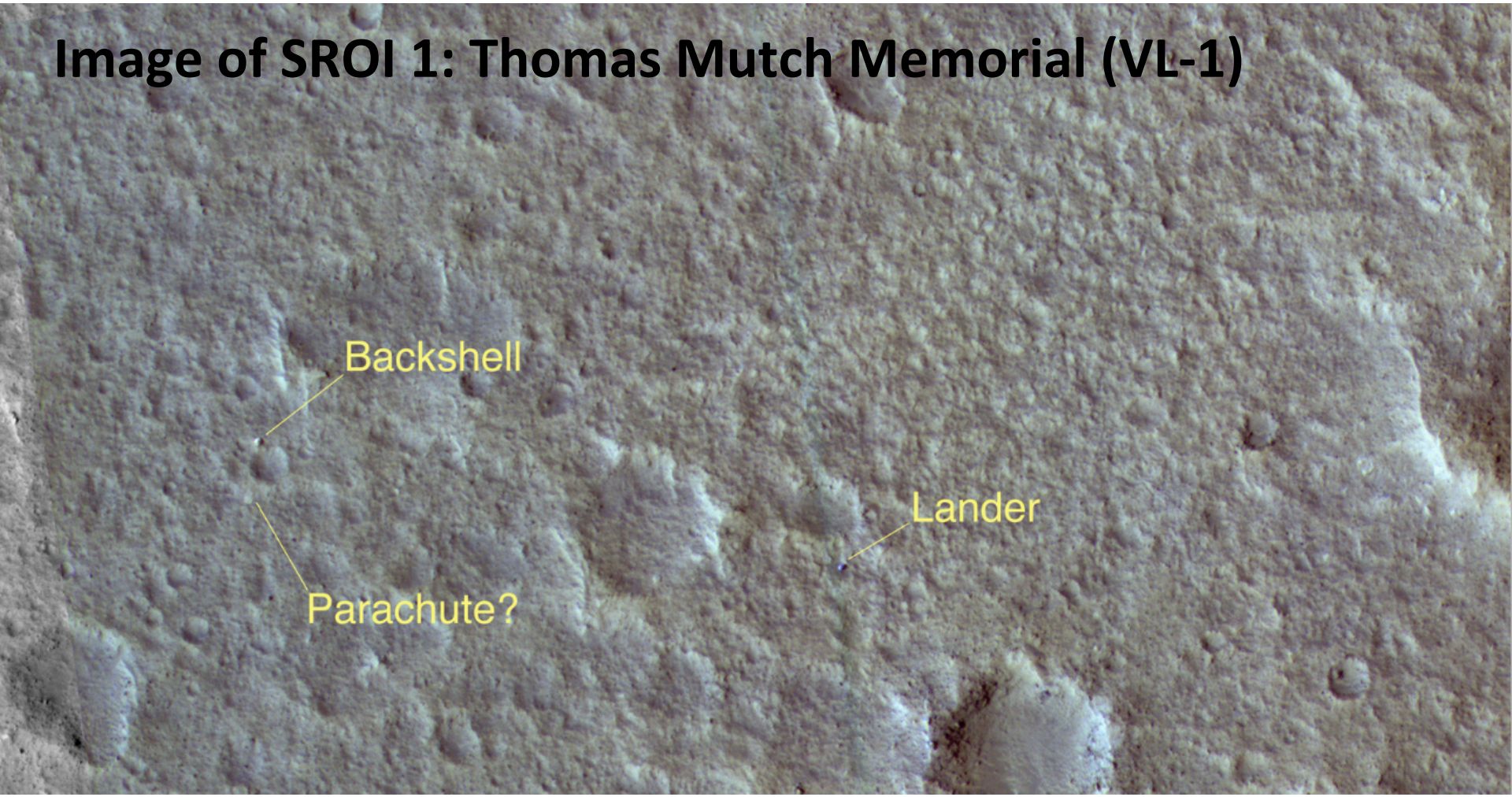
Southwest Geotraverse: Maja Vallis erosional landforms (S2, S3)

North-South Geotraverse: Xanthe Dorsa wrinkle ridge (S4, S5)

Study of Impact Crater Features : central peak, RSLs, ramparts (S6)

Chryse Planitia Science ROI 1

Image of SROI 1: Thomas Mutch Memorial (VL-1)



From Univ. of Arizona HIRISE PSP_001521_2025

Chryse Planitia Science ROI 1

Overview of Science at SROI1: 22.4N, 48.0W

From NASA SP-425

Decades-long time series study of Atmospheric Science

- Retrieval and study of VL-1 lander hardware
- Sustained exposure of infrastructure to conditions on the Martian surface
- A rich assemblage of petrologic samples, some with trapped atmospheric gases
- Morphological changes to site and VL-1 since 1982
- Re-investigate soils at the VL-1 site for evidence of either current habitability or fossil biosignatures

Re-examination of VL-1 astrobiologic findings

- Examine drift deposits for presence of ice and organics

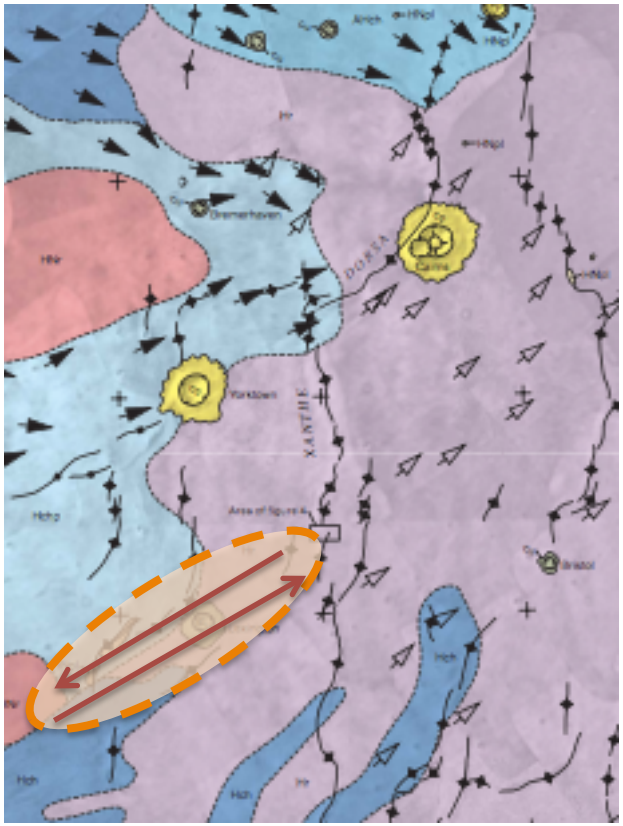
Chryse Planitia Science ROI 1

Changes in color of control drift at VL-1 site – possible exposure of darker (basaltic?) soils

from Guinness et al. 1980

Chryse Planitia Science ROI 2 & 3

Image of SROI 2 and 3



from Crumpler et al. 2001

Overview of Science at SROI 2 (21.9N, 48.9W) and SROI 3 (21.5N, 49.1W)

Investigate landforms from aqueous processes

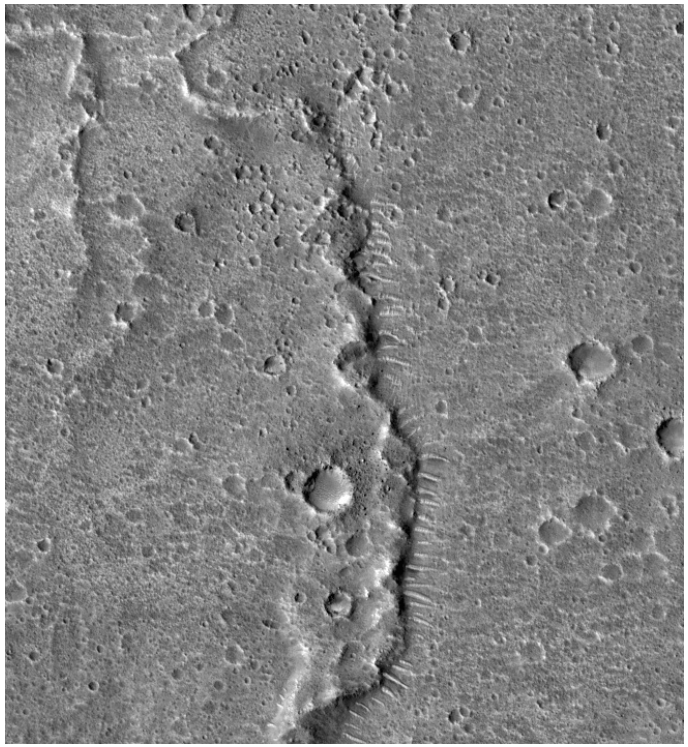
- Geotraverse to southwest toward the western margin of the Chryse Basin, a depositional plain
- Possible transit of outflow for late Hesperian channel systems in catchment areas
- Travel upstream towards the Maja fan to reveal history of these flooding events and their deposits
- Statistical variations in the numbers and types of cobbles, boulders and sediments -- clues to origin of the parent rocks found in the deposit

Examine evidence for astrobiology

- Possible pre-Amazonian (Noachian?) astrobiologic habitats upstream of the Chryse Basin; placed from floodwaters depositing detritus

Chryse Planitia Science ROI 4 & 5

Image of SROI 4 and 5



Representative section of Xanthe Dorsa from HIRISE (Univ. Arizona)

Overview of Science at SROI 4 (21.2N, 47.9W) and SROI 5 (23.5N, 48.1W)

Geoscience investigation of datable surfaces

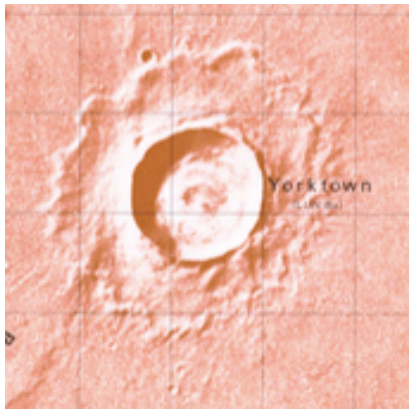
- Geotraverse to south and north along Xanthe Dorsa wrinkle ridge – one of basin-wide system of ridged plains (Head et al., 2002)
- Early Hesperian compression event preceding late Hesperian aqueous events
- Transit along prominent Xanthe Dorsa for evidence of geochemical gradients of early Hesperian volcanism
- Examination of highly modified crater rims, possibly of early Hesperian age

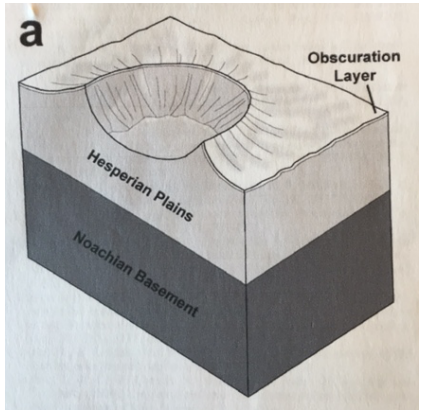
Investigate landforms from aqueous processes

- Locate transition from erosion to deposition
- Extent of Maja Vallis deposit from southwest and Kasei Vallis deposit from northwest

Chryse Planitia Science ROI 6

Image of SROI 6





from Salvatore et al., 2010

Overview of Science at SROI 6 (23.1N, 48.6W)

Geoscience investigation of relative ages

- Examination of pristine impact crater for ground truth evidence of mafic Hesperian basalt (Salvatore et al., 2010)
- Confirmation of CRISM near-infrared signature of shallow subsurface olivine and clinopyroxene
- Possible central peak upwelling of deeply buried Hesperian/Noachian(?) bedrock

Investigate landforms from aqueous processes

- Possible evidence of aqueous processes in rampart formation of crater ejecta margins
- Possible RSL formation in crater rim
- Sampling of deposit formation from crater rim and ejecta blanket

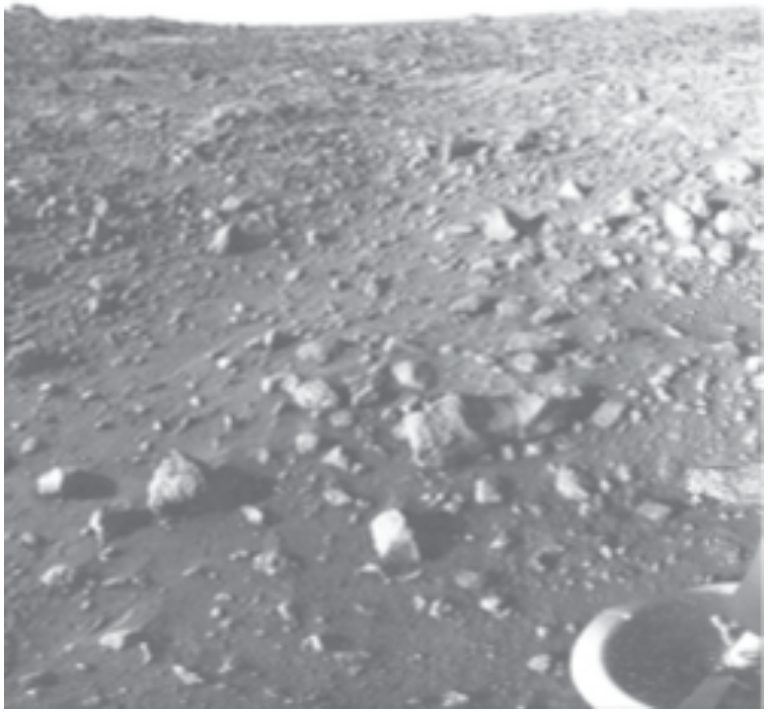
RESOURCE ROIs

Study of VL-1 Landing Site and Vicinity (S1, R1)

Northwest Geotraverse: Kasei Vallis erosional/depositional landforms (R2)

Chryse Planitia Resource ROI 1

Image of RROI 1



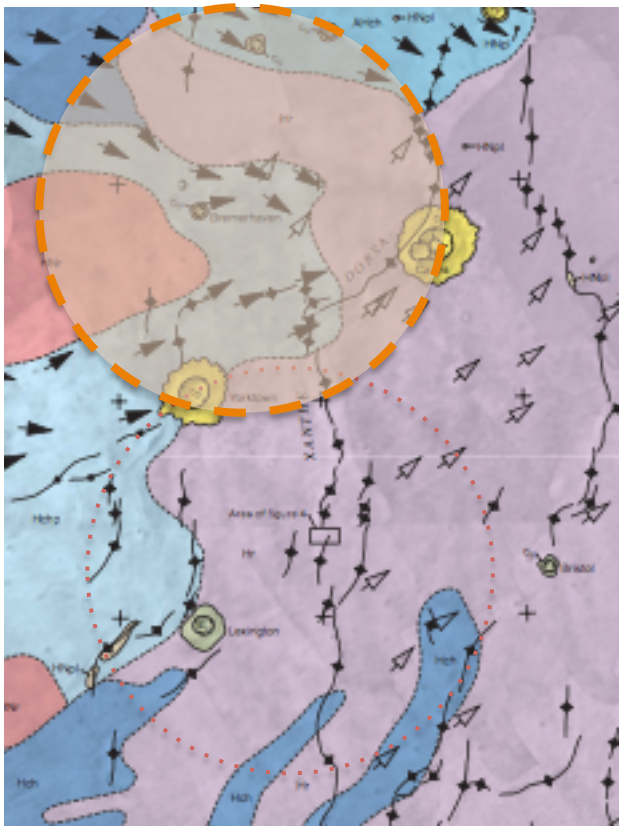
from Crumpler et al. 2001

Overview of Resources at RROI1 (22.3N, 48.3W)

- Adjacent to the VL-1 lander with well-imaged surface
- Outcrops of volcanic bedrock and stratified drift deposits
- Substantial evidence of providing cobbles, regolith, and basalt
- Basalt-based silica and metal feedstocks for LS and Habitation Zone (HZ) in-situ resource utilization (ISRU) and infrastructure construction by highly automated equipment
- Potential for readily accessible ice deposits

Chryse Planitia Resource ROI 2

Image of RROI 2



from Crumpler et al. 2001

Overview of Resources at RROI2 (24.6N, 49.5W)

- An extensive resource ROI to the north of the EZ may center on the confluence of several channel systems
- Recent analytical consensus indicates that these channels may have terminated in a standing body of water
- Outflow areas of Kasei Vallis from the northwest which may have had more than one episode of erosion
- Partly-sorted material may have been deposited from floodwaters that coursed through these channel systems
- Potential for readily accessible ice deposits

RUBRICS

Summary of the Chryse Planitia EZ include:

Latitude near 30°N for likelihood of near surface **water ice** in excess of 100MT

Elevation (−2 km) for atmosphere for a **safe descent** of robotic and human landers

Relief of <100 m for **construction** of large planar platforms and transportation corridors

Slopes of <10° for **stability** at touchdown of robotic and human landers

Accessible rocks, drift deposits and moderate sized boulders for construction material

A **load-bearing surface** that shows evidence of bedrock in outcrops

The Chryse Planitia EZ is uniquely suited to provide detailed study of the VL-1 site to discern morphologic changes to the landscape and weathering changes since 1982.

Chryse Planitia Science ROIs Rubric

1st EZ Workshop for Human Missions to Mars

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

Key	
●	Yes
○	Partial Support or Debated
	No
?	Indeterminate

Chryse Planitia Resource ROIs Rubric

1st EZ Workshop for Human Missions to Mars

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

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

Highest Priority Chryse Planitia EZ Data Needs

The proposed Chryse Planitia EZ centered near the VL-1 landing site has evidence for adequate water ice, silica, and load-bearing bedrock surface resources to utilize as infrastructure for long-term missions to support humans.

Significant scientific inquiries into environments conducive to possible astrobiosignatures, Martian surface processes and the geologic history of Mars could be enhanced through extension of investigations begun in the Viking era into the 2030's and beyond.

What is the single most important additional data set needed to assess the science potential of the EZ? Presence and composition of organic matter.

What is the single most important additional data set needed to assess the resource potential of the EZ? Presence and depth of water ice deposits.