Columbia Base: The Dawn of a New Era

Abstract #1008

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Why Go To Mars?

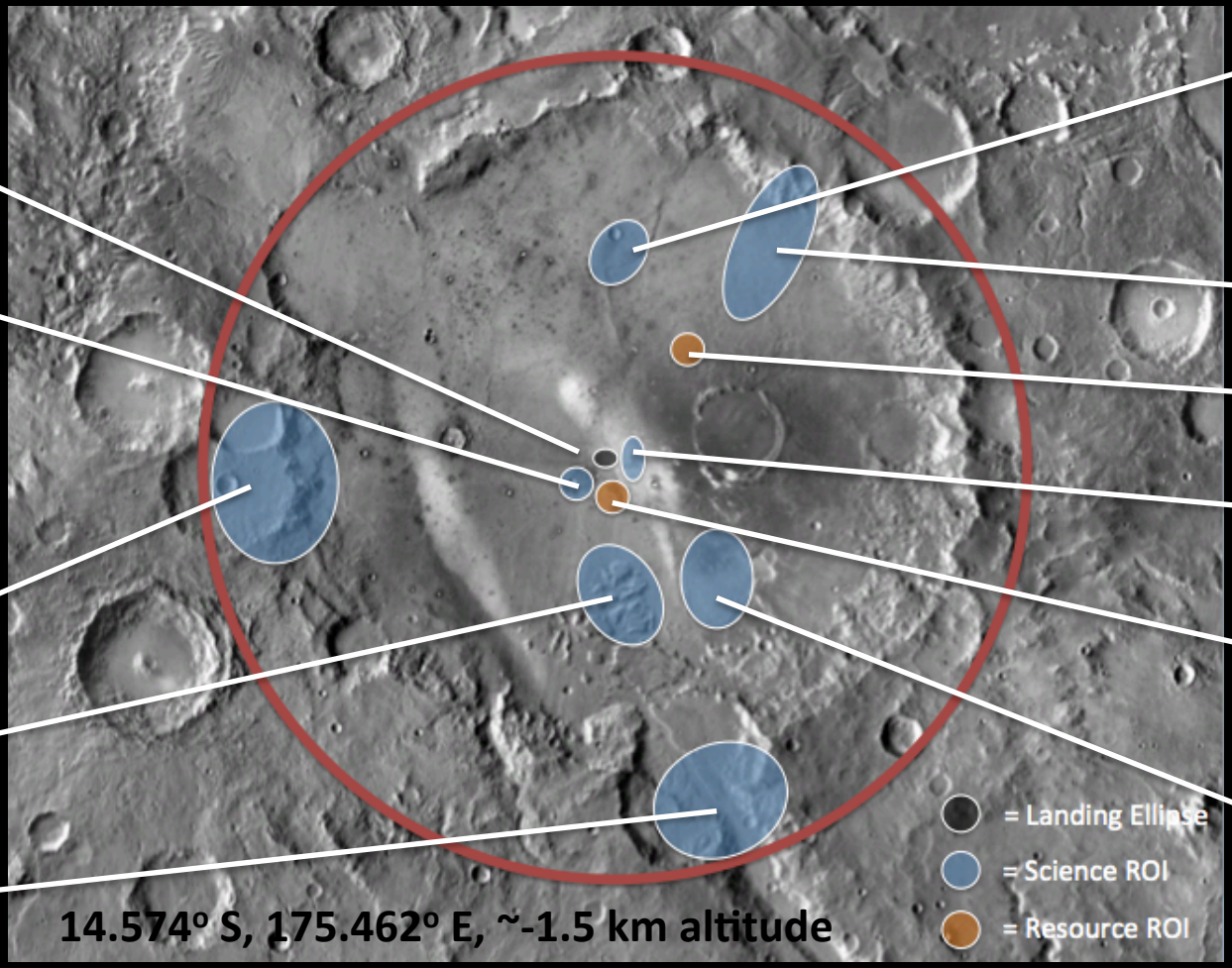
"It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow."

- Robert Goddard

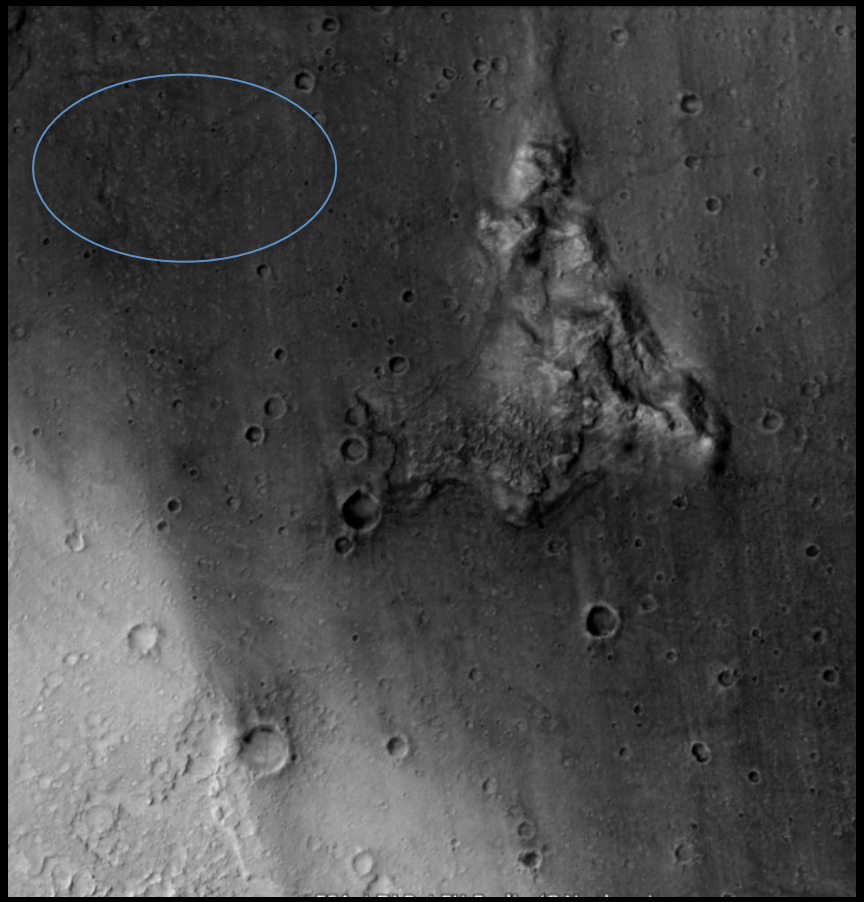
"We choose to go to the Moon in this decade and do the other things, not because they are easy, but because they are hard."

- John F. Kennedy

Exploration Zone Map



Engineering Safety



- Few landing site obstructions
- Easily navigable by a human pilot
- Adjacent to science, resources
- Traversable EZ

Science ROI(s) Rubric

1st EZ Workshop for Human Missions to Mars

Science Site Criteria			AND/OR	Site Factors		SROI 1	SROI 2	SROI 3	SROI 4	SROI 5	SROI 6	SROI 7	SROI 8	RROI 1	RROI 2	EZ SUM
	Astrobio	Threshold		**Potential for past habitability**		●	●	○		●	●	○		○	●	5, 3
				Potential for present habitability/refugia			?					○		○	●	1, 3
		Qualifying		Potential for organic matter, w/ surface exposure		●	●	●		●	●	●		●	●	8, 0
	Atmospheric Science	Threshold		**Noachian/Hesperian rocks w/ trapped atmospheric gases**	●	●	●	●	●	●	●	●	●	●	●	11, 0
		Qualifying		Meteorological diversity in space and time	●	●	●	●	●	●	●	●	●	●	●	11, 0
				High likelihood of surface-atmosphere exchange	●	●	○	●	○	○	●	●	○	●	●	7, 4
				Amazonian subsurface or high-latitude ice or sediment								?		?	○	0, 3
				High likelihood of active trace gas sources												0, 0
	Geoscience	Threshold		**Range of martian geologic time; datable surfaces**	●	●	●	●	●	●	●	●	●	●	●	11, 0
				Evidence of aqueous processes		●	○	●		●	●	○		○	○	4, 4
				Potential for interpreting relative ages	●	○	○	●	●	○	○	○	●	○	○	4, 7
		Qualifying		Igneous Rocks tied to 1+ provinces or different times	●	●	●	●	●		●	○	●	○	○	7, 3
				Near-surface ice, glacial or permafrost			?					○		○	●	1, 3
				Noachian or pre-Noachian bedrock units					○							0, 1
				Outcrops with remnant magnetization												0, 0
				Primary, secondary, and basin-forming impact deposits	●	○		●	●	●	○	●	●			6, 2
				Structural features with regional or global context	●	●	○	●	●	●	●	●	●	●	●	10, 1
				Diversity of aeolian sediments and/or landforms	●	●	●	●	●	●	●	●	●	●	●	11, 0

Key

- ● Yes
- ○ Partial Support or Debated
- No
- ? Indeterminate

DISCLAIMER: This rubric was filled out by an amateur planetary scientist. It is intended to simply serve as a source to influence further discussion.

Resource ROI(s) Rubric

1st EZ Workshop for Human Missions to Mars

ISRU and Civil Engineering Criteria				Site Factors	Landing site	SROI 1	SROI 2	SROI 3	SROI 4	SROI 5	SROI 6	SROI 7	SROI 8	RROI 1	RROI 2	EZ SUM
	Engineering			Meets First Order Criteria (Latitude, Elevation, Thermal Inertia)	●	●	●	●	●	●	●	●	●	●	●	11, 0
	Water Resource	Threshold	AND/OR	**Potential for ice or ice/regolith mix**			?					○		○	●	1, 3
				Potential for hydrated minerals		●	○			●	●	○		○	●	4, 3
				Quantity for substantial production			○			●	●	●		●	●	5, 1
				Potential to be minable by highly automated systems		●					●	●		●	●	5, 0
				Located less than 3 km from processing equipment site		●								●		2, 0
				Located no more than 3 meters below the surface		●				●	●	●		●	●	6, 0
				Accessible by automated systems	●	●	●	●	●	●	●	●	●	●	●	11, 0
		Qualifying		Potential for multiple sources of ice, ice/regolith mix **and** hydrated minerals			○					●		●	●	3, 1
				Distance to resource location can be >5 km			●	●	●	●	●	●	●		●	8, 0
				Route to resource location must be (plausibly) traversable	●	●	●	●	●	●	●	●	●	●	●	11, 0
	Civil Engineering	Threshold		**~50 sq km region of flat and stable terrain with sparse rock distribution**	●					●	●	○	●	○		4, 2
				1–10 km length scale: <10°	●					●	●		●			4, 0
				Located within 5 km of landing site location	●	●								●		3, 0
		Qualifying		Located in the northern hemisphere												0, 0
				Evidence of abundant cobble sized or smaller rocks and bulk, loose regolith	●	●						●	●	●		5, 0
				Utilitarian terrain features		●	●	●		●		●	●	●	●	8, 0
	Food Production	Qualifying		Low latitude	●	●	●	●	●	●	●	●	●	●	●	11, 0
				No local terrain feature(s) that could shadow light collection facilities	●						●	●	●	●		5, 0
				Access to water			?					○		○	●	1, 3
				Access to dark, minimally altered basaltic sands	●	●					○	○	●	○		3, 3
	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	●	●	●	●	●	●	●	●	●	●	●	11, 0
		Qualifying		Potential for multiple sources of metals/silicon	?	?	?	?	?	?	?	?	?	?	?	?
				Distance to resource location can be >5 km			●	●	●	●	●	●	●		●	8, 0
				Route to resource location must be (plausibly) traversable	●	●	●	●	●	●	●	●	●	●	●	11, 0

Key

- ● Yes
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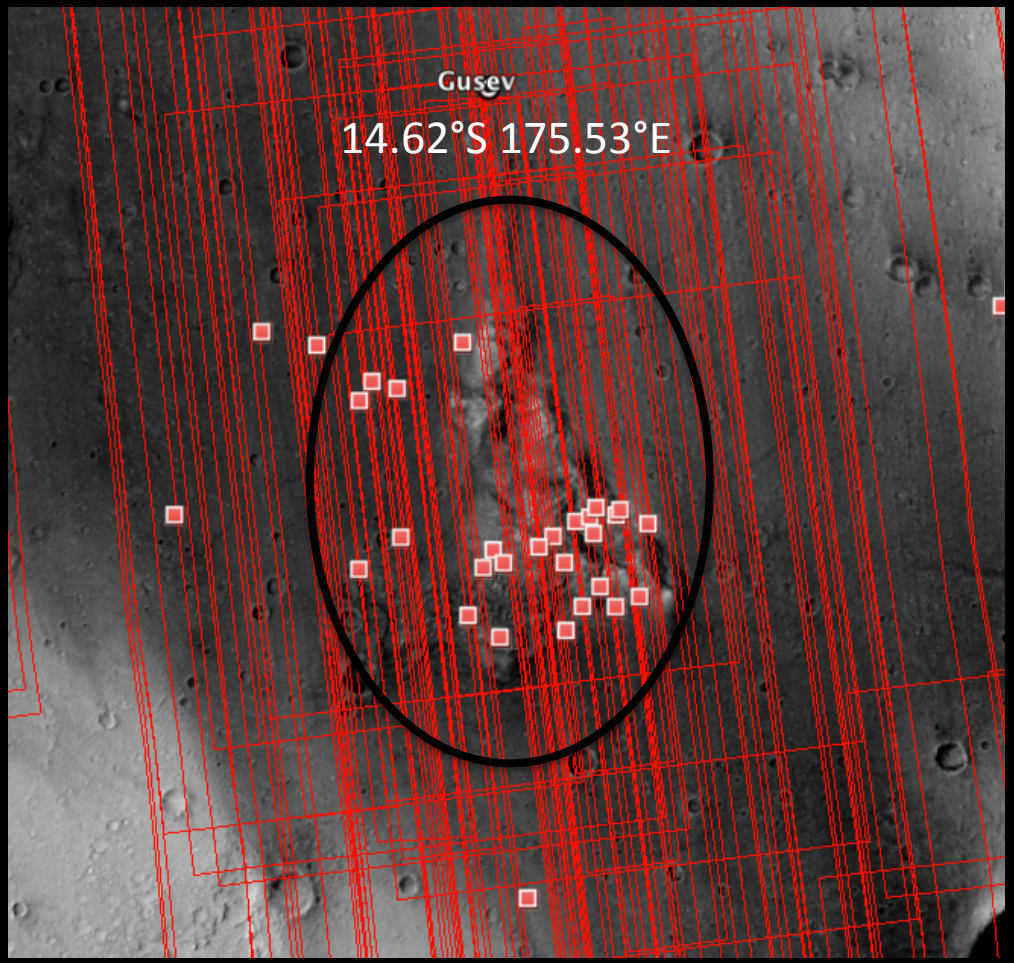
Science ROI 1: Columbia Hills



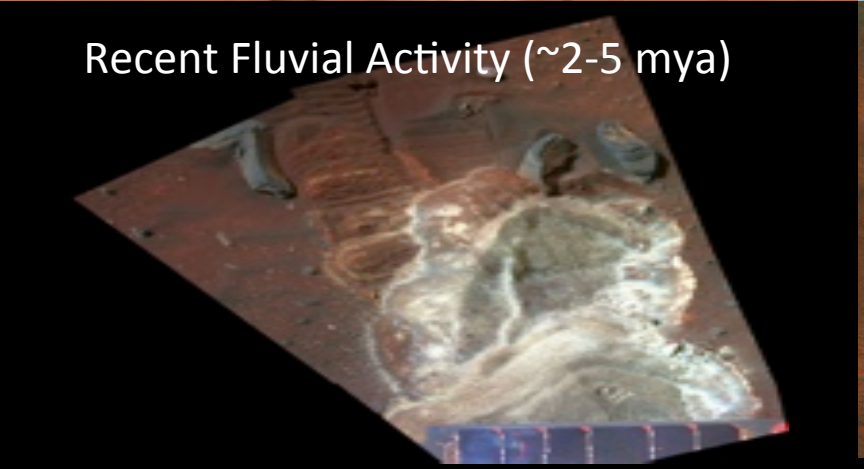
- An Ancient Hydrothermal System
- Carbonates and Ancient Lakes
- Periods of Volcanic and Aqueous Activity (volcanic tephra basin fill)
- Recent Fluvial Activity (~2-5 mya)
- Ground truth from Spirit
- Datable volcanic surface

Major Spirit Discoveries ROI 1

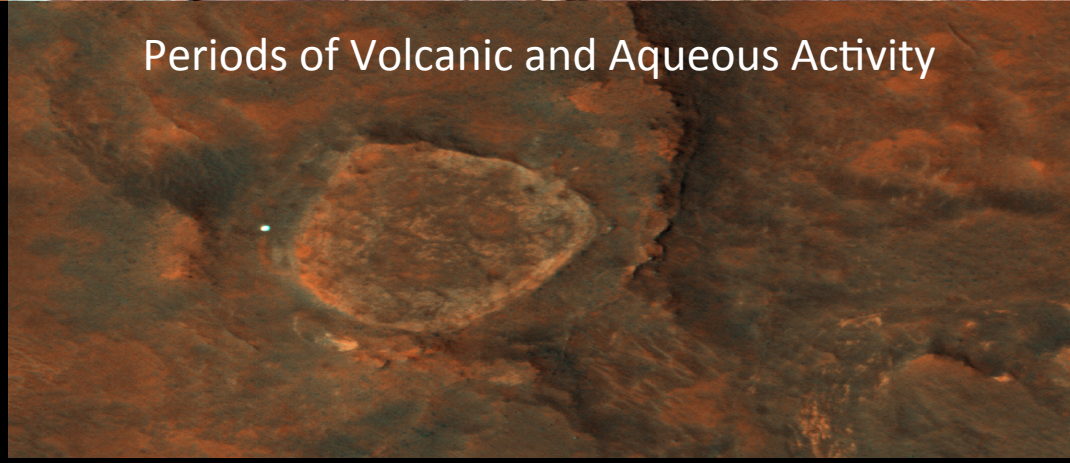
An Ancient Hydrothermal System

Carbonates and Ancient Lakes

Recent Fluvial Activity (~2-5 mya)



Periods of Volcanic and Aqueous Activity



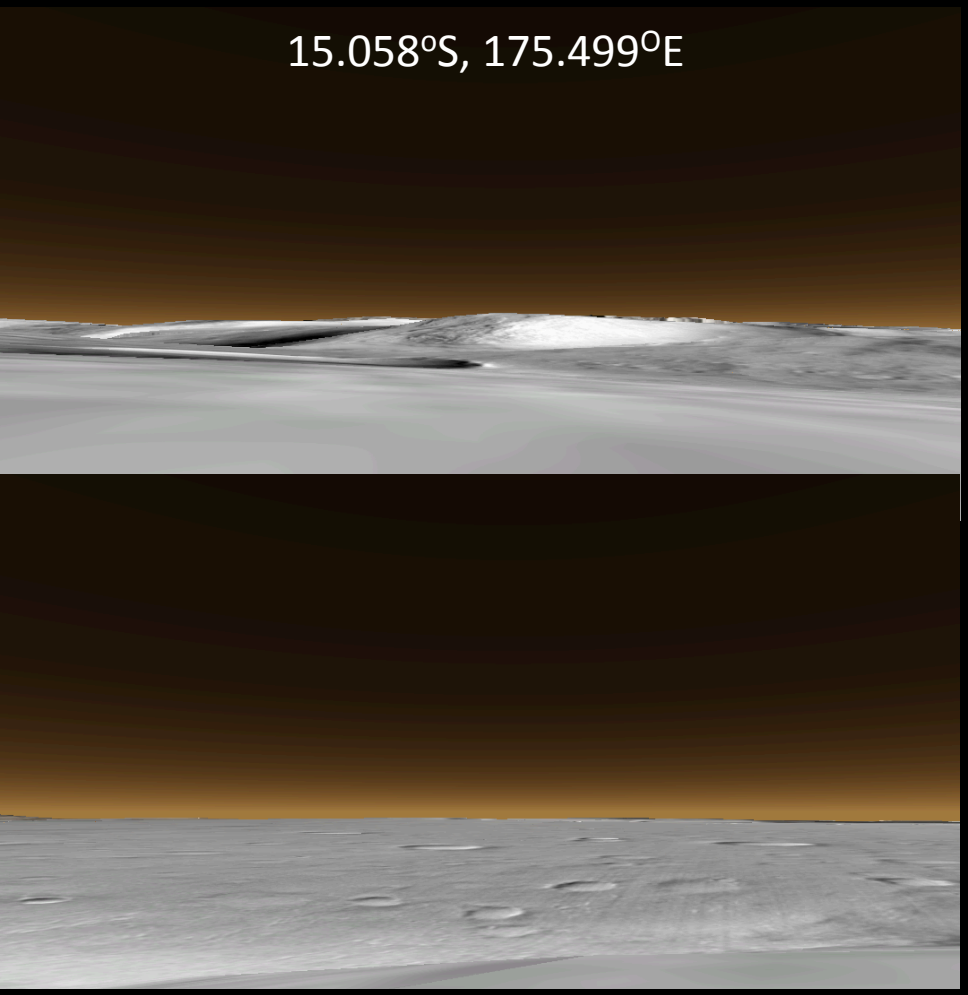
A Habitable Environment ROI 1

El Tatio Hydrothermal Field, Chile, Earth

Columbia Hills, Gusev Crater, Mars

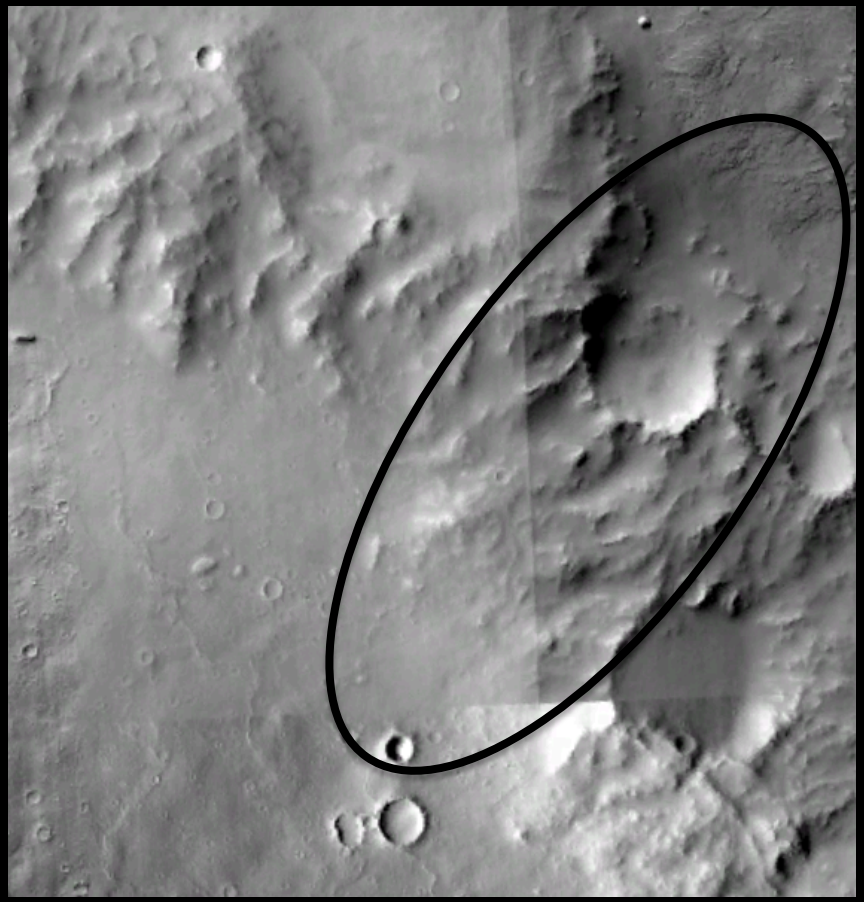
Credit: Steve Ruff

Science ROI 2: Mesas



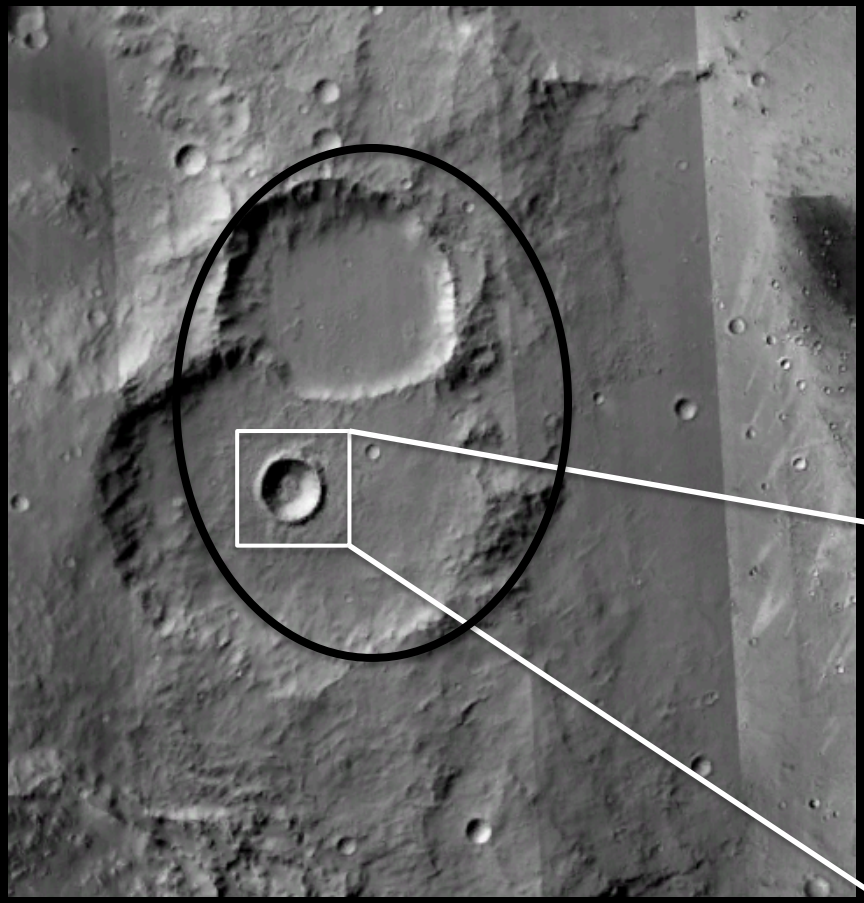
- Mesas located at the mouth of Ma'adim Vallis
- Origins are unknown, but the mesas could be a flood deposit, deltaic remnant, or chaotic terrain
- 400-500 meters tall
- Only 1 HiRISE image, no CRISM
- Surrounded by volcanic plains

Science ROI 3: Eroded Crater Rim

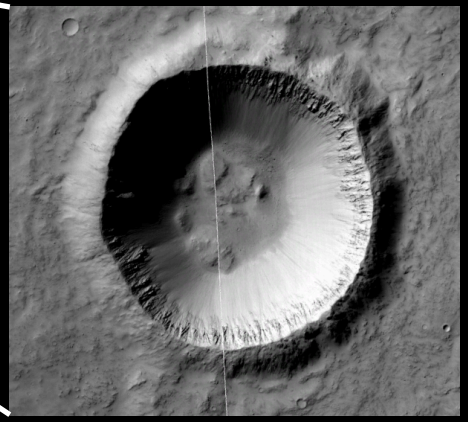


- 13.600°S, 176.499°E
- Record of climate change includes Noachian, Hesperian, Amazonian eras
- Extensive fluvial alteration
- No imagery coverage

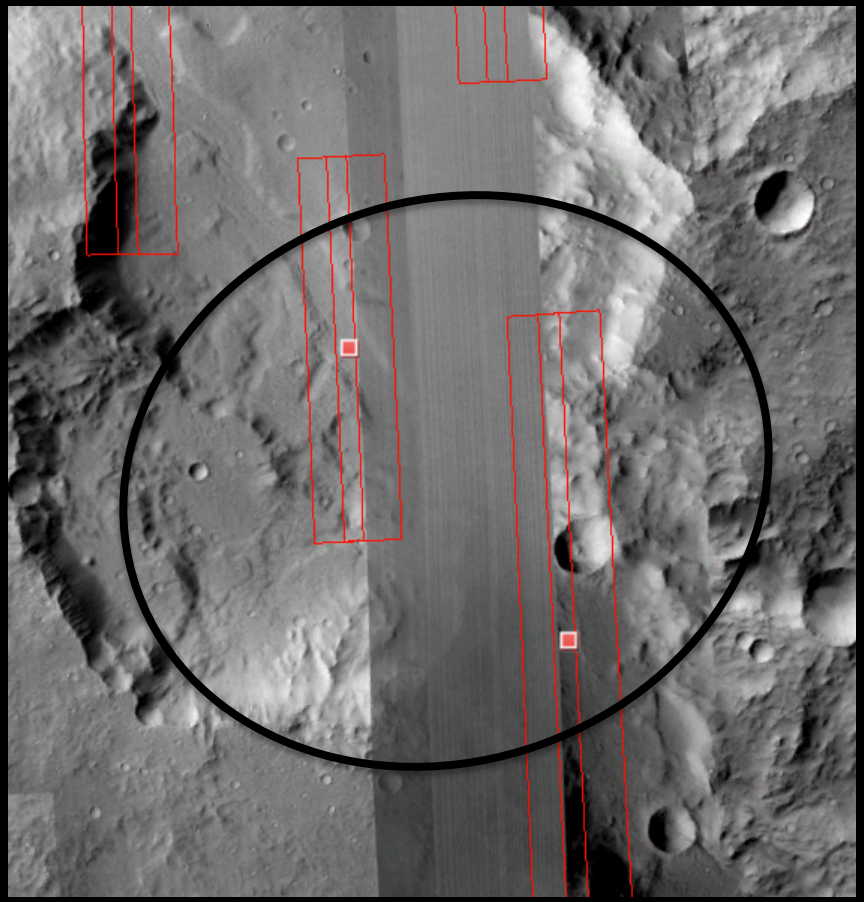
Science ROI 4: Secondary Craters



- 14.764°S, 173.962°E
- Younger impacts
- “Windows” into geologic past
- Concentric craters

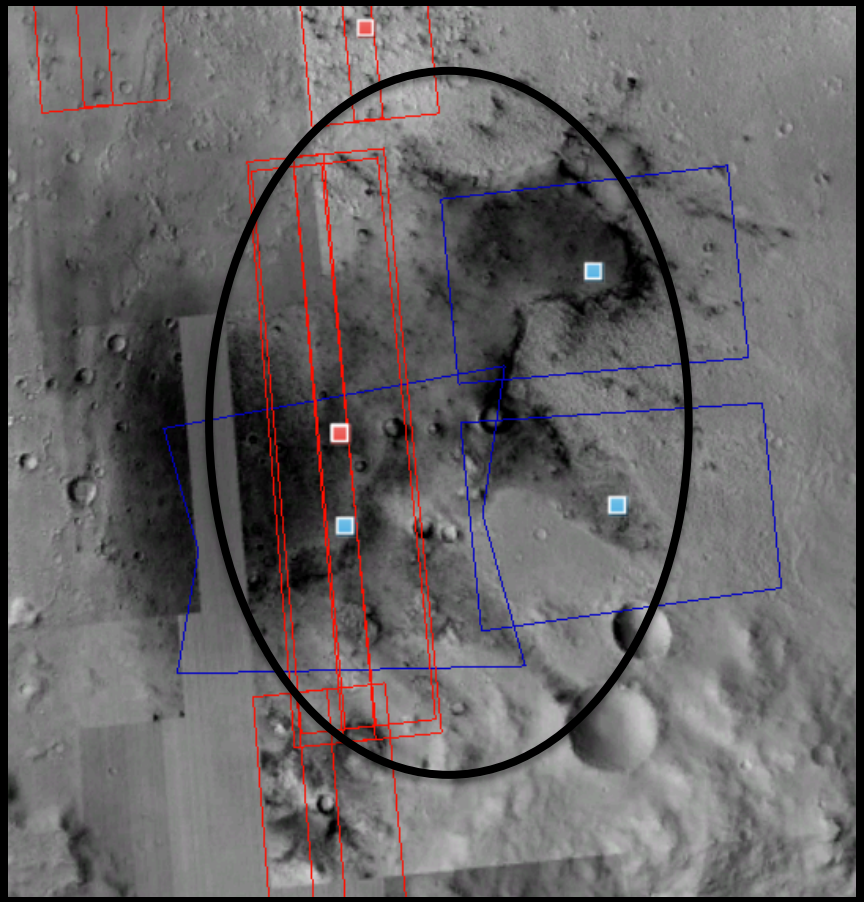


Science ROI 5: Ma'adim Vallis



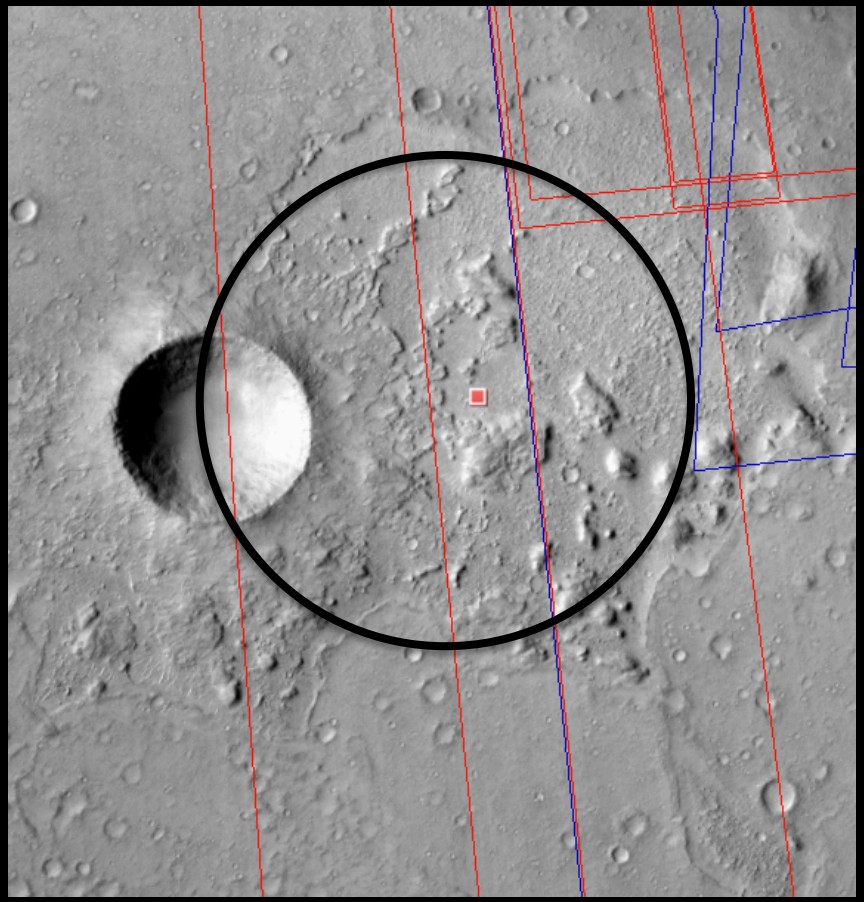
- 15.841°S, 175.918°E
- Postulated source of Gusev Crater's water
- Layered rocks preserve ancient habitable environments

Science ROI 6: Clays

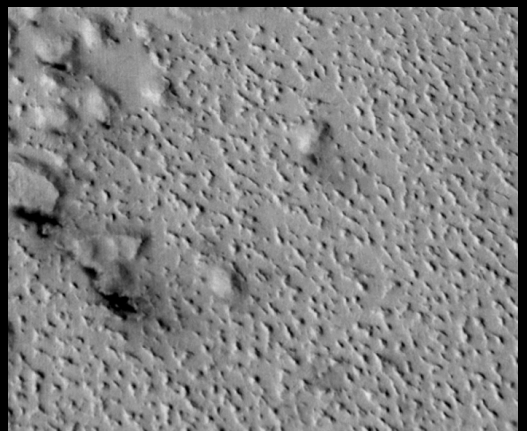


- 15.143°S, 176.014°E
- Widespread deposits
- Formed in a habitable, pH-neutral environment
- Fe-rich, Al-rich clays present (climate change in the presence of water)

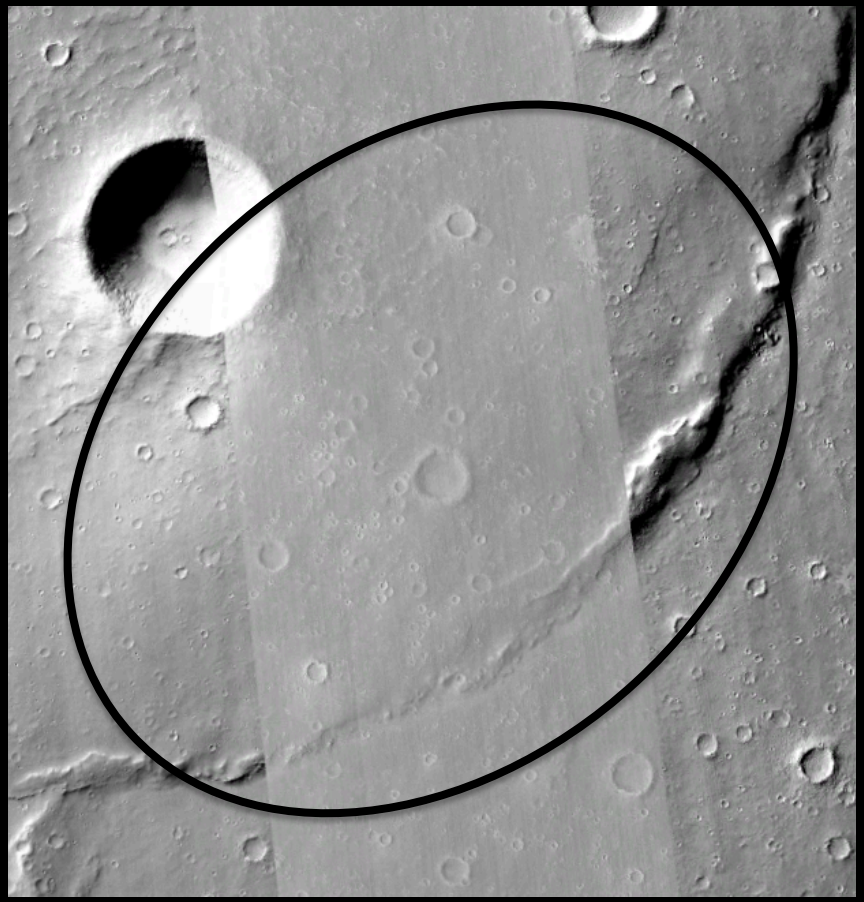
Science ROI 7: Etched Terrain



- 14.530°S, 175.333°E
- Glacial origin???
- Wind erosion???
- Similar thermal inertia to ancient layers
- Unique to Mars

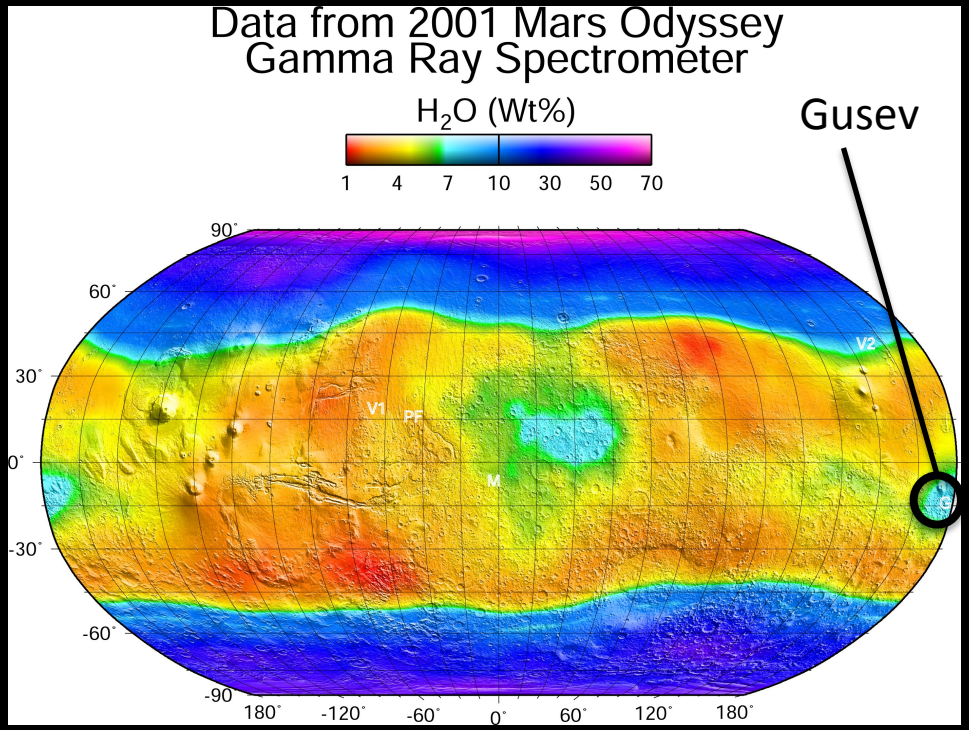


Science ROI 8: Basaltic Plains



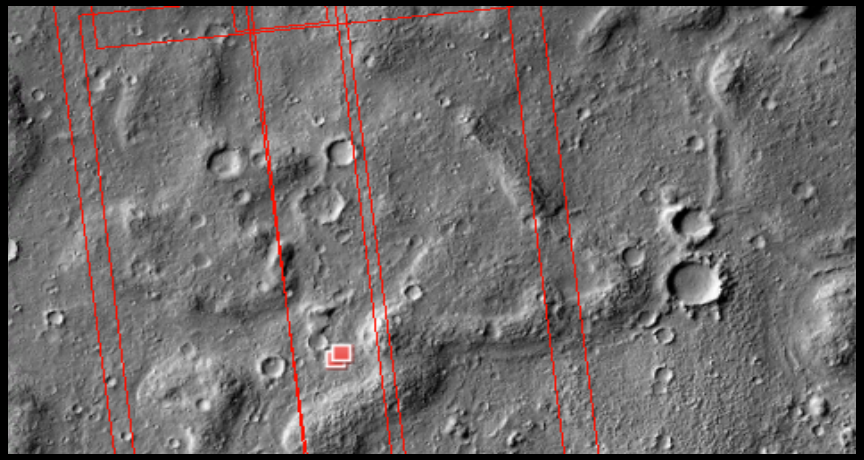
- 13.587°S, 175.489°E
- Allows for interpretation of absolute age
- Formed during Hesperian era
- Tectonic/volcanic wrinkle ridge
- No imaging available

Resource ROI 1: Etched Terrain



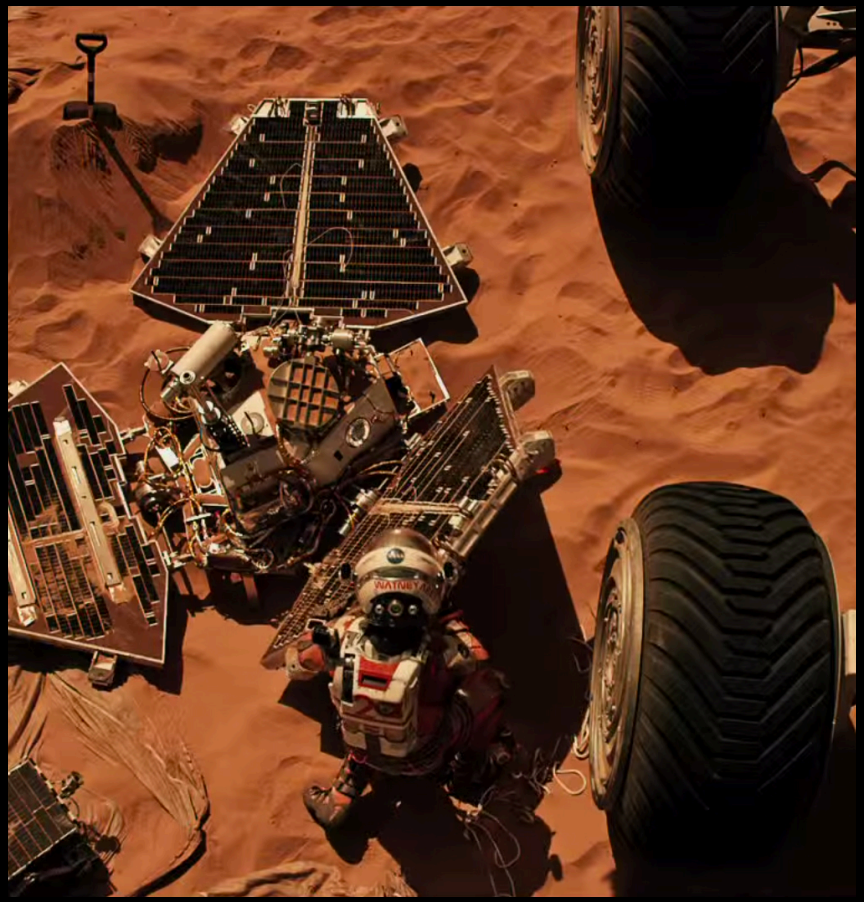
- >2% water abundance throughout the soil
- Abnormal for an equatorial site
- All resource ROIs do not jeopardize planetary protection concerns

Resource ROI 2: Pingos



- 14.194°S, 175.839°E
- Permafrost is an extremely effective preserver of organic material, and even fossil microbes
- Pingos can also be used as a major source of water
- Accessible ~ 30 km from EZ center

Resource ROI 3: "The Great Spirit Rescue Mission"



- Enrichment resource! We can repair Spirit as a tool for future explorers
- "If it isn't impossible, it isn't worth doing."

  - Marc Rayman
- Spirit can inform us on how mechanical components weather in the environment (Jim Rice)

Prioritization List of EZ Data Needs

1. Mars 2020 rover mission (long-term objective)
    - Confirm/disprove potential biosignature
    - Ground truth >1 science, >1 resource ROIs
    - Acquire environmental data on Spirit hardware
    - Assemble collection of ROI 1 returnable samples
2. Additional CRISM and HiRISE coverage of all ROIs, except Columbia Hills

    CRISM of mesas (SROI 2) is highest priority (understand the history of the environment)
3. MARSIS radar data on pingos (are they really permafrost?)

Honoring the past, innovating in the present, and hoping for the future, we will pioneer the final frontier of space for the future of all mankind.

Thank You!

"What I really want for our rovers, more than anything else, is boot prints in our wheel tracks."

- Steve Squyres, MER Principal Investigator

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