Ground Truth Assessment of Gale Crater Using MSL Data for Characterization of Potential Human Mission Landing Site and ISRU

Workshop Abstract #1040

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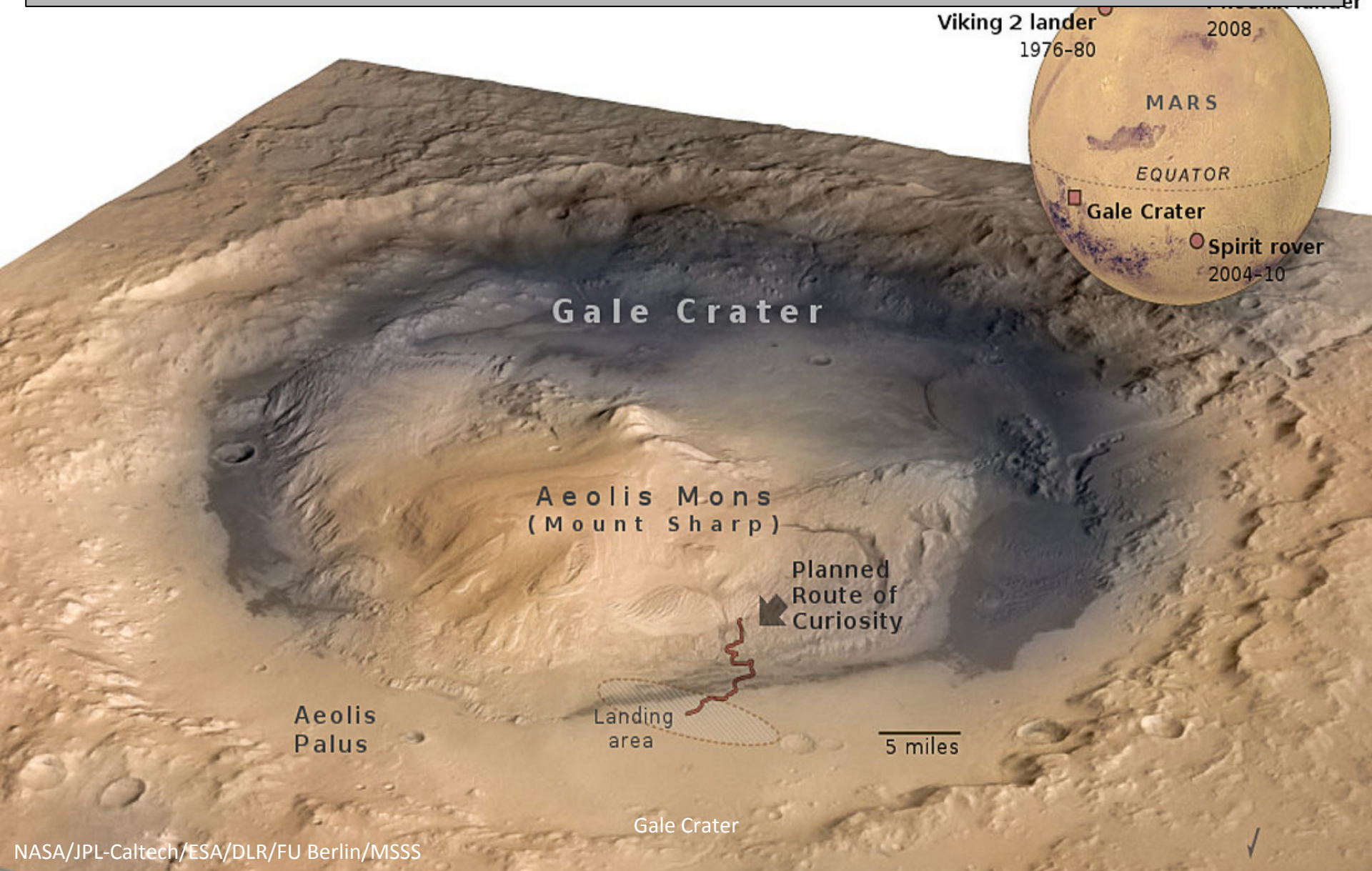
NASA/JPL-Caltech/MSSS

- 137.8°E, 5.4°S
- LS ~4 m below datum
- Crater formed ~ 3.5 Ga
- Ancient lake



Gale Crater

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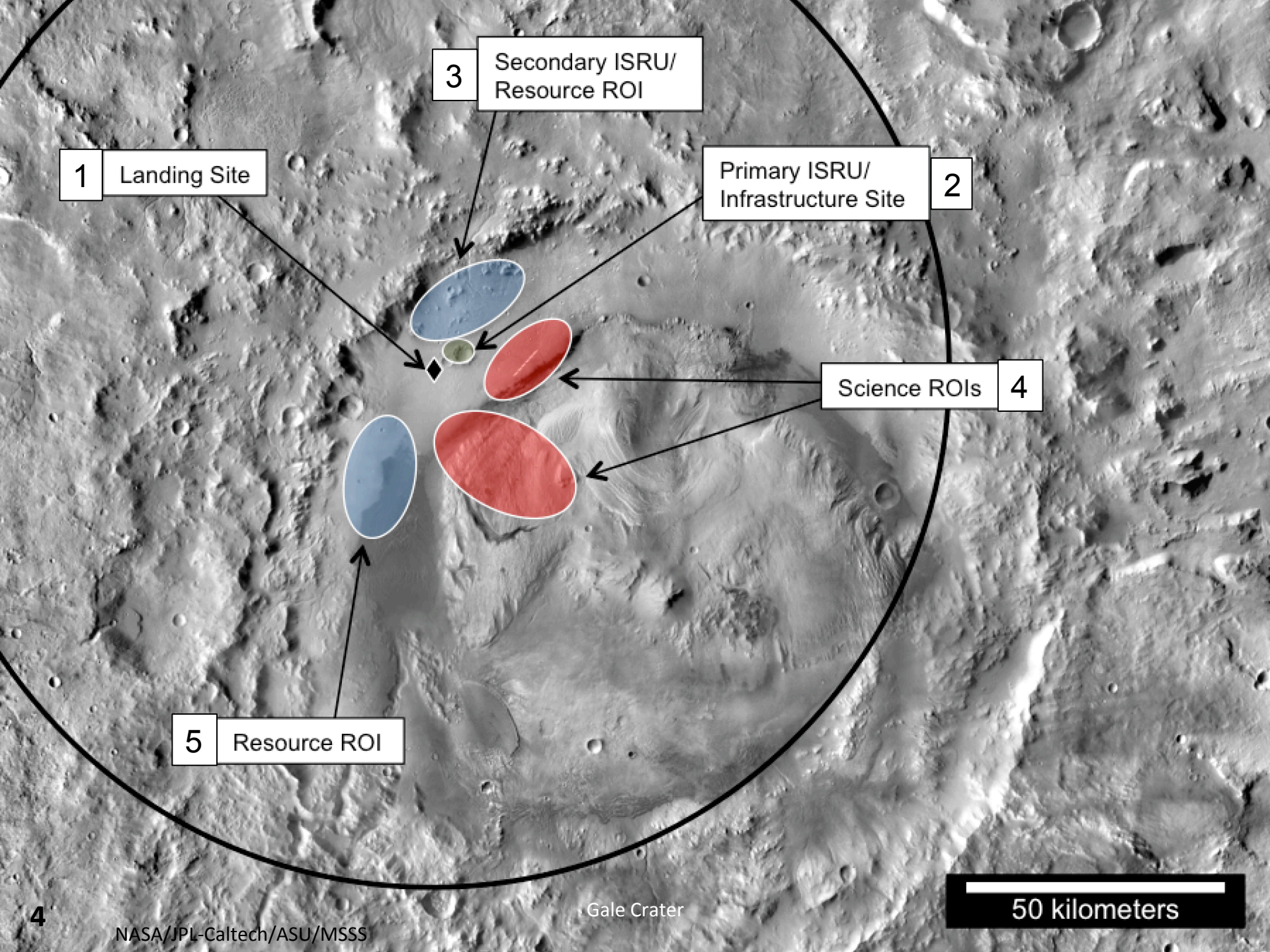
If humans landed at Gale crater tomorrow, how would they fare?

The Martian, 20th Century Fox



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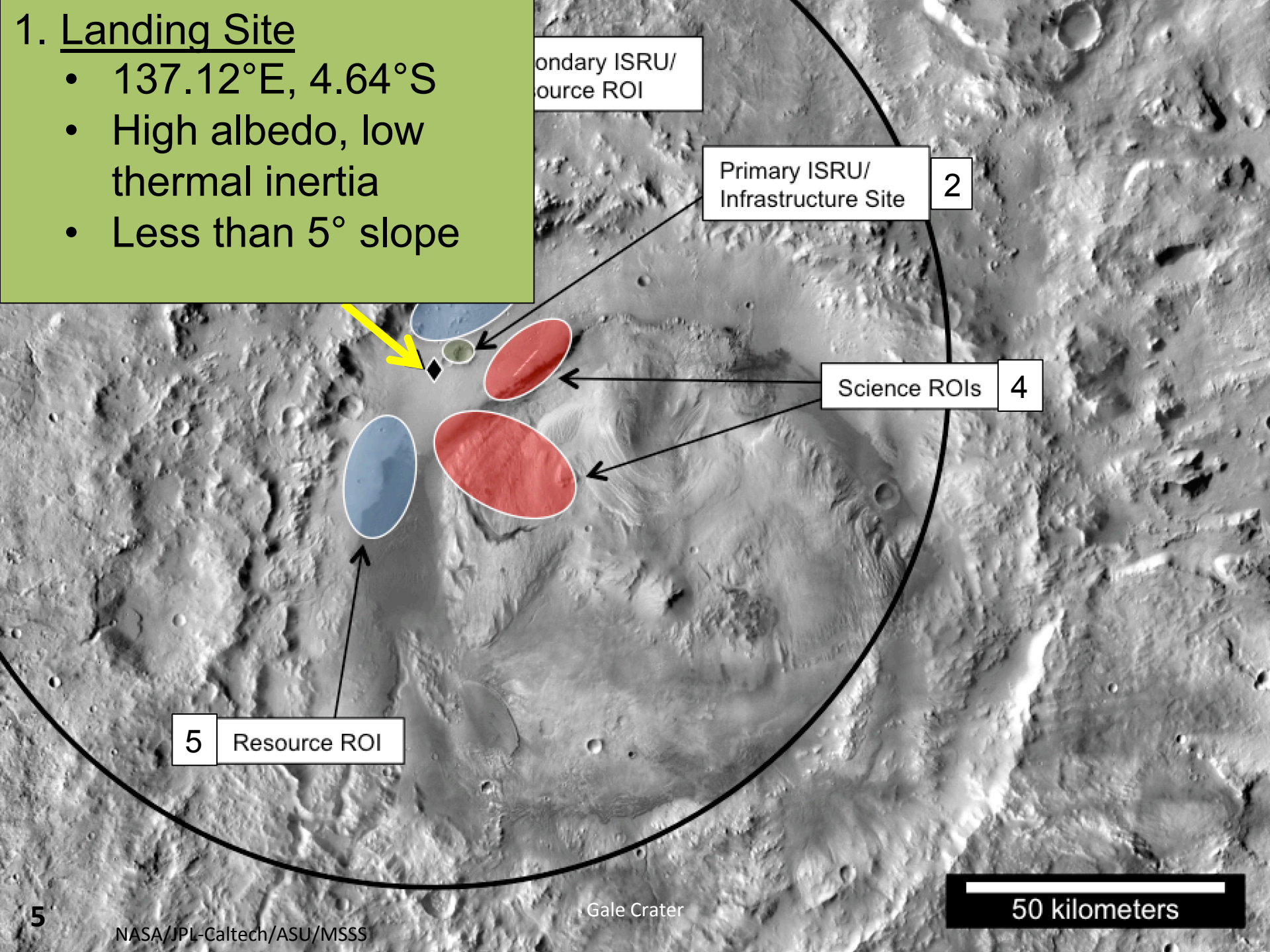
1. Landing Site
- 137.12°E, 4.64°S
- High albedo, low thermal inertia
- Less than 5° slope



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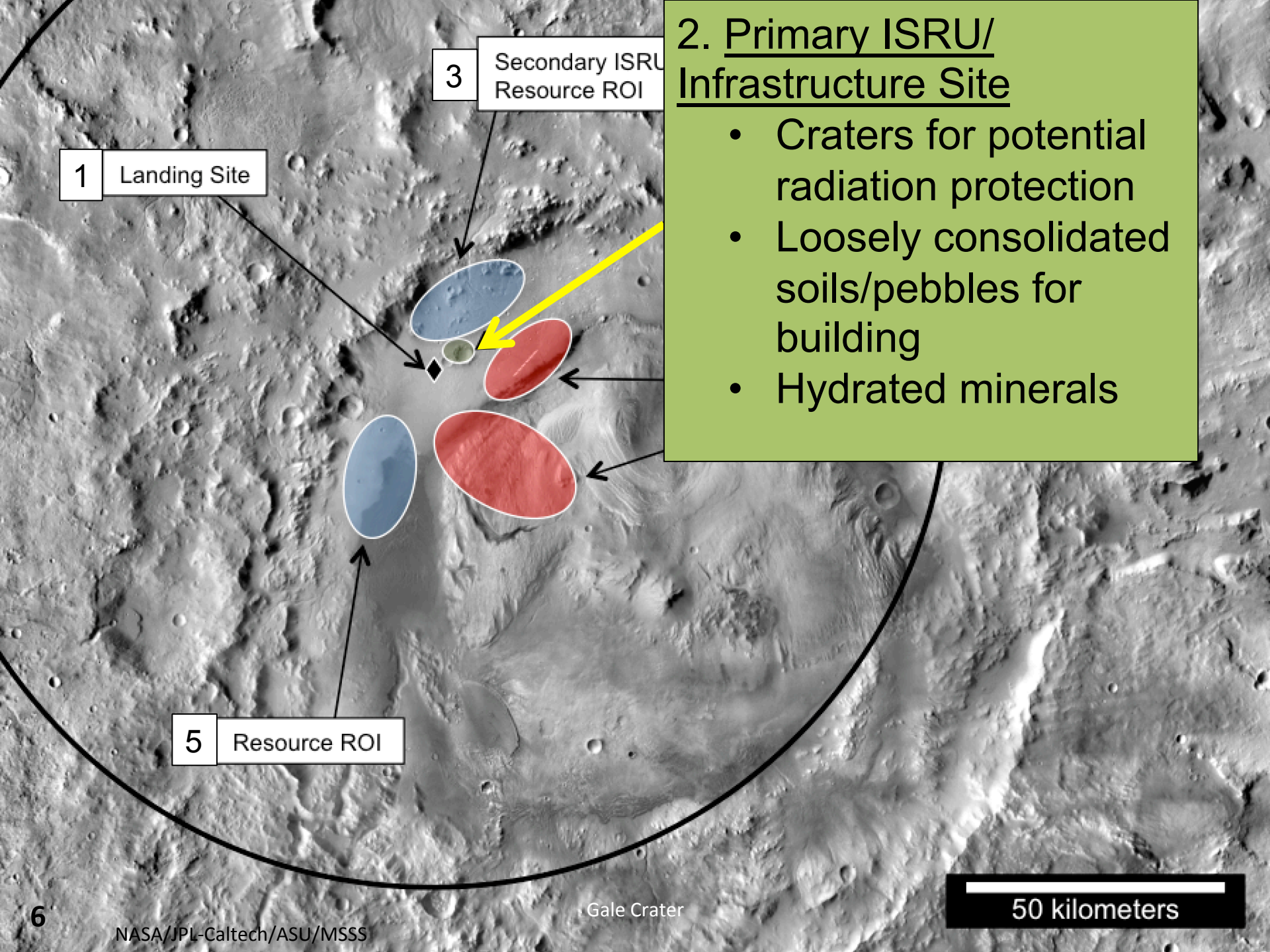

2. Primary ISRU/ Infrastructure Site

- Craters for potential radiation protection
- Loosely consolidated soils/pebbles for building
- Hydrated minerals

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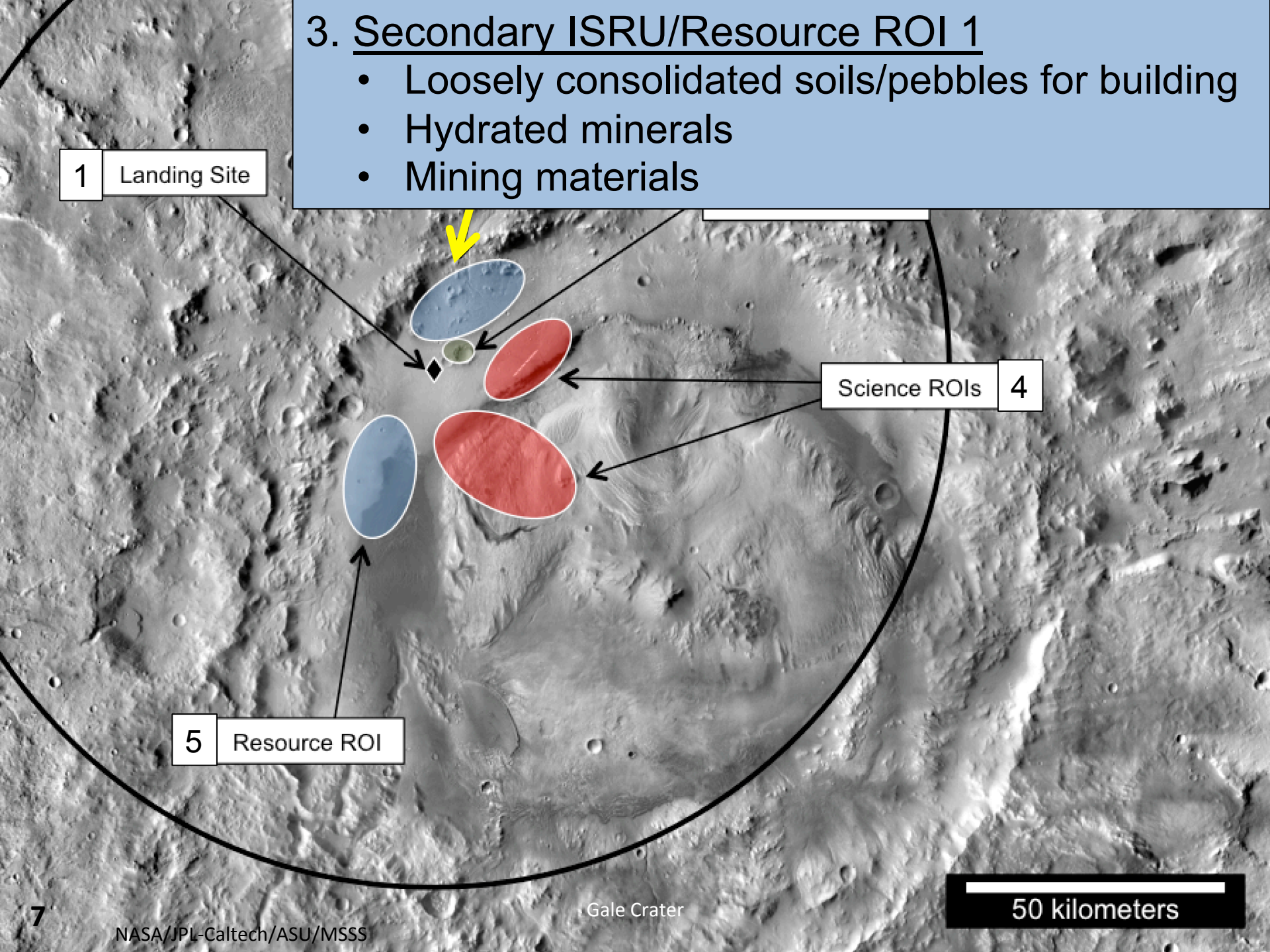
3. Secondary ISRU/Resource ROI 1

- Loosely consolidated soils/pebbles for building
- Hydrated minerals
- Mining materials



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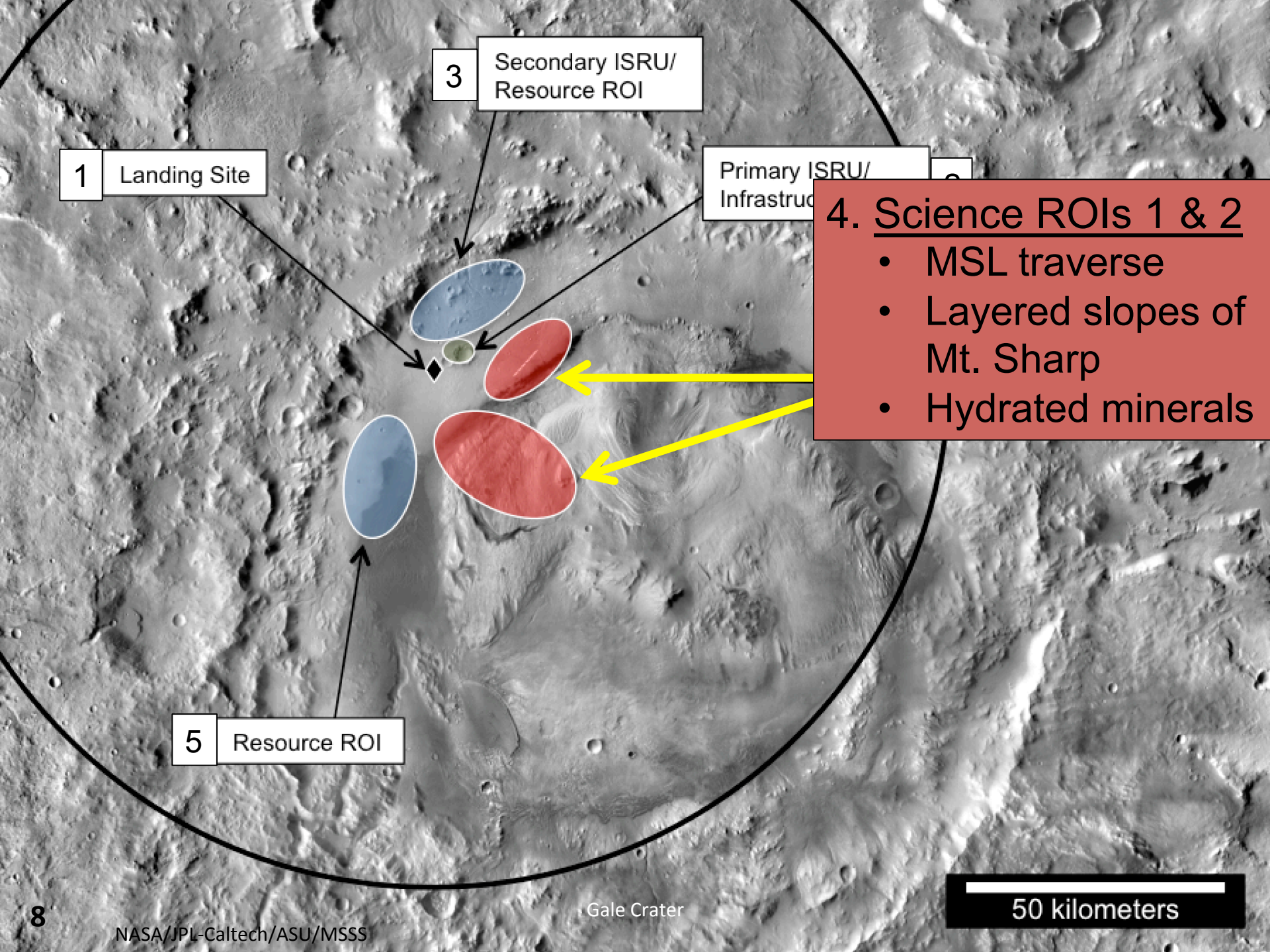

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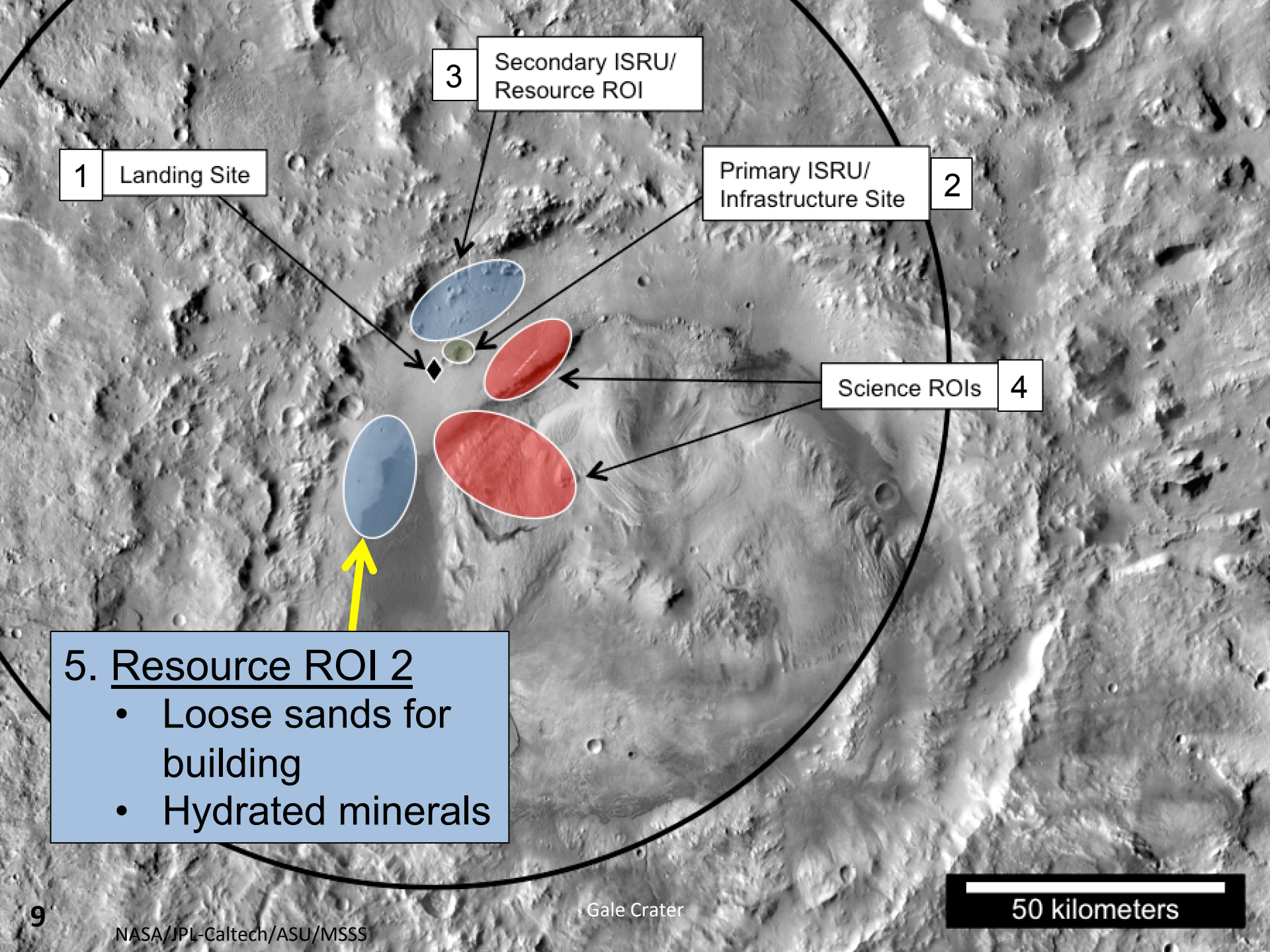

5. <u>Resource ROI 2</u>
   - Loose sands for building
   - Hydrated minerals

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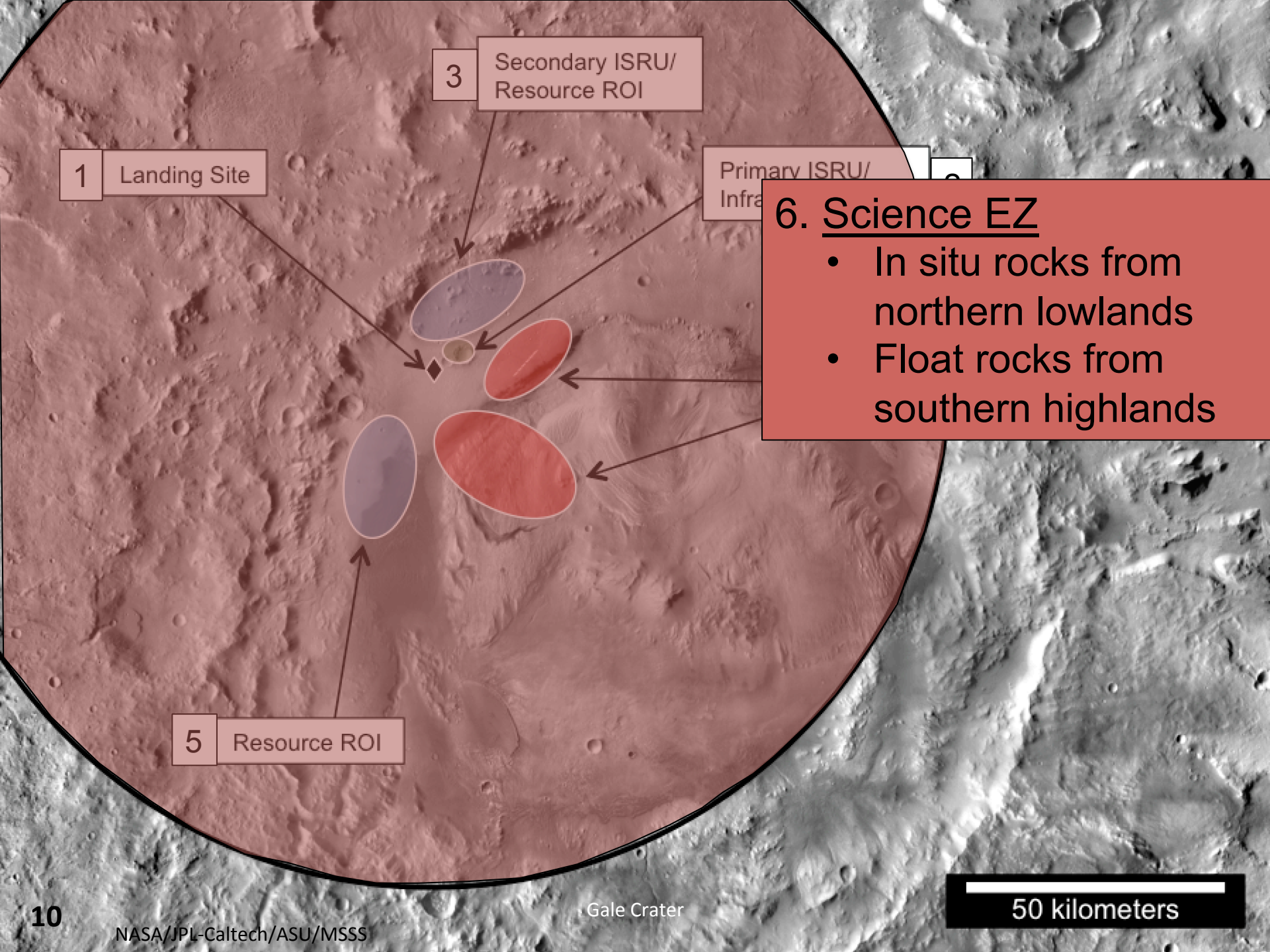

6. <u>Science EZ</u>
- In situ rocks from northern lowlands
- Float rocks from southern highlands

Gale Crater

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Science ROIs Rubric

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

Key	
●	Yes
○	Partial Support or Debated
	No
?	Indeterminate

Resource ROI(s) Rubric

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

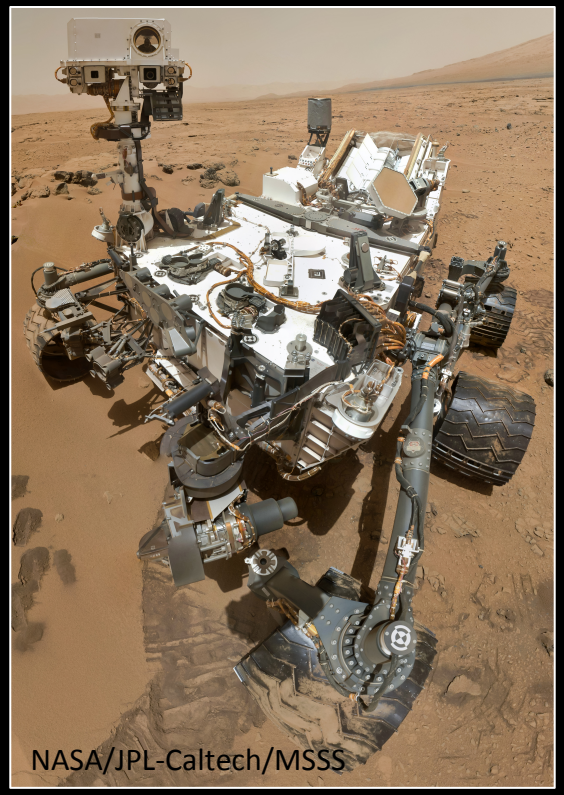
Key	
●	**Yes**
○	**Partial Support or Debated**
	No
?	**Indeterminate**

Objectives

- Survive
- Confirm MSL discoveries of habitability
- Search for life while avoiding contamination
- Complete thorough classification of region

Tools

- Rover
- Building materials
- MSL experience, data set



Gale Crater

Advantages - Science

- Traversable surface
- Regional-scale outcrops
- Stratigraphic materials
- Accessible highlands & lowlands materials
- Accessible impacts
- Collection of analyzed rocks & soils to further investigate

Advantages - ISRU

- Loose materials for building
- Cratered areas for radiation shielding
- Hydrated minerals as a water source
- High Fe, Al, & Si for mining

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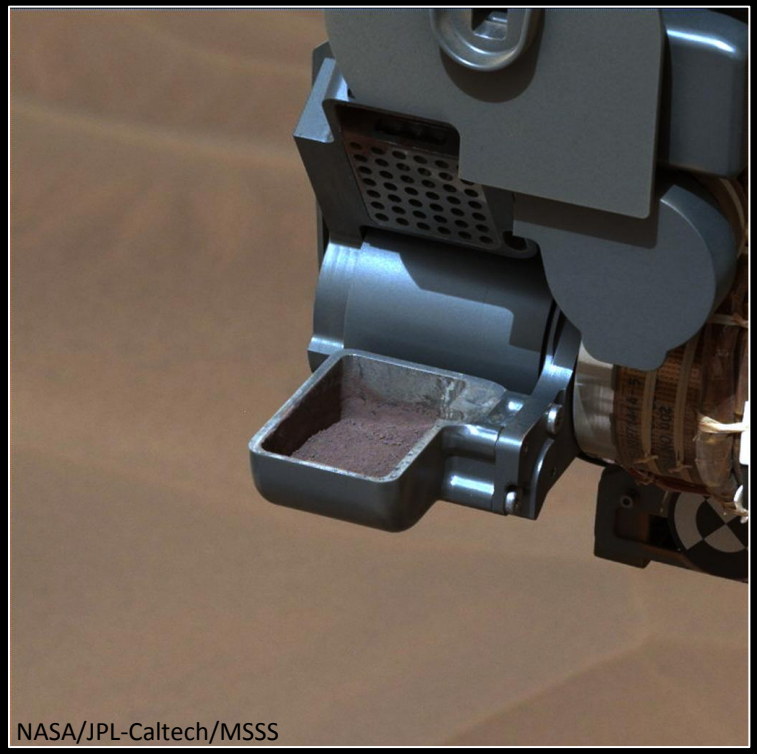
Gale Crater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Disadvantages - ISRU

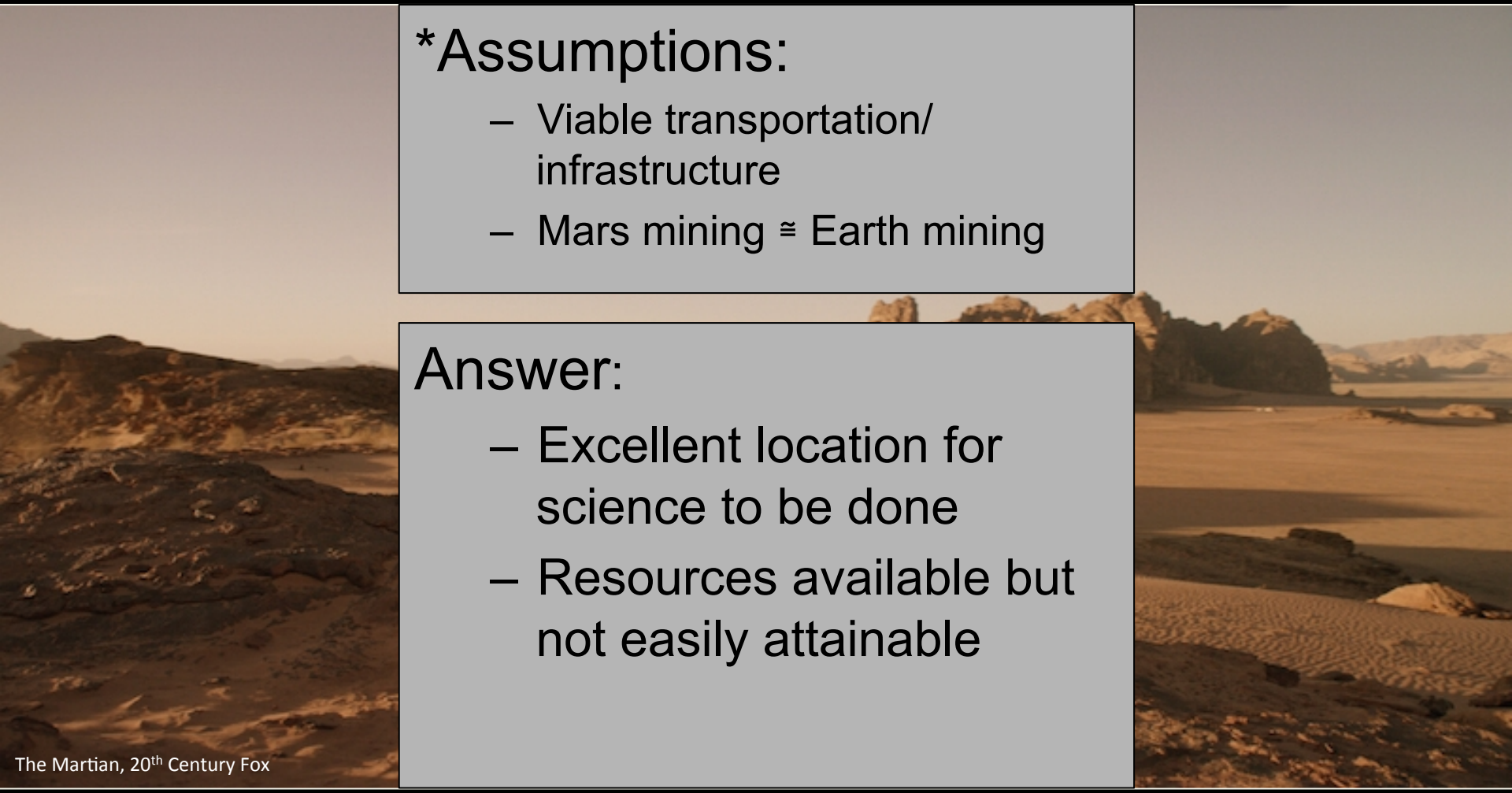
- No clear evidence of subsurface water ice
- Not enough Fe, Al for terrestrial mining standards
- No evidence of subsurface structures to be used as underground shelter

Disadvantages - Science

- No access to Amazonian water ice
- No clear evidence of hydrothermal/volcanic processes

Gale Crater

If humans landed at Gale crater tomorrow, how would they fare?*



The Martian, 20th Century Fox

*Assumptions:

- Viable transportation/ infrastructure
- Mars mining ≅ Earth mining

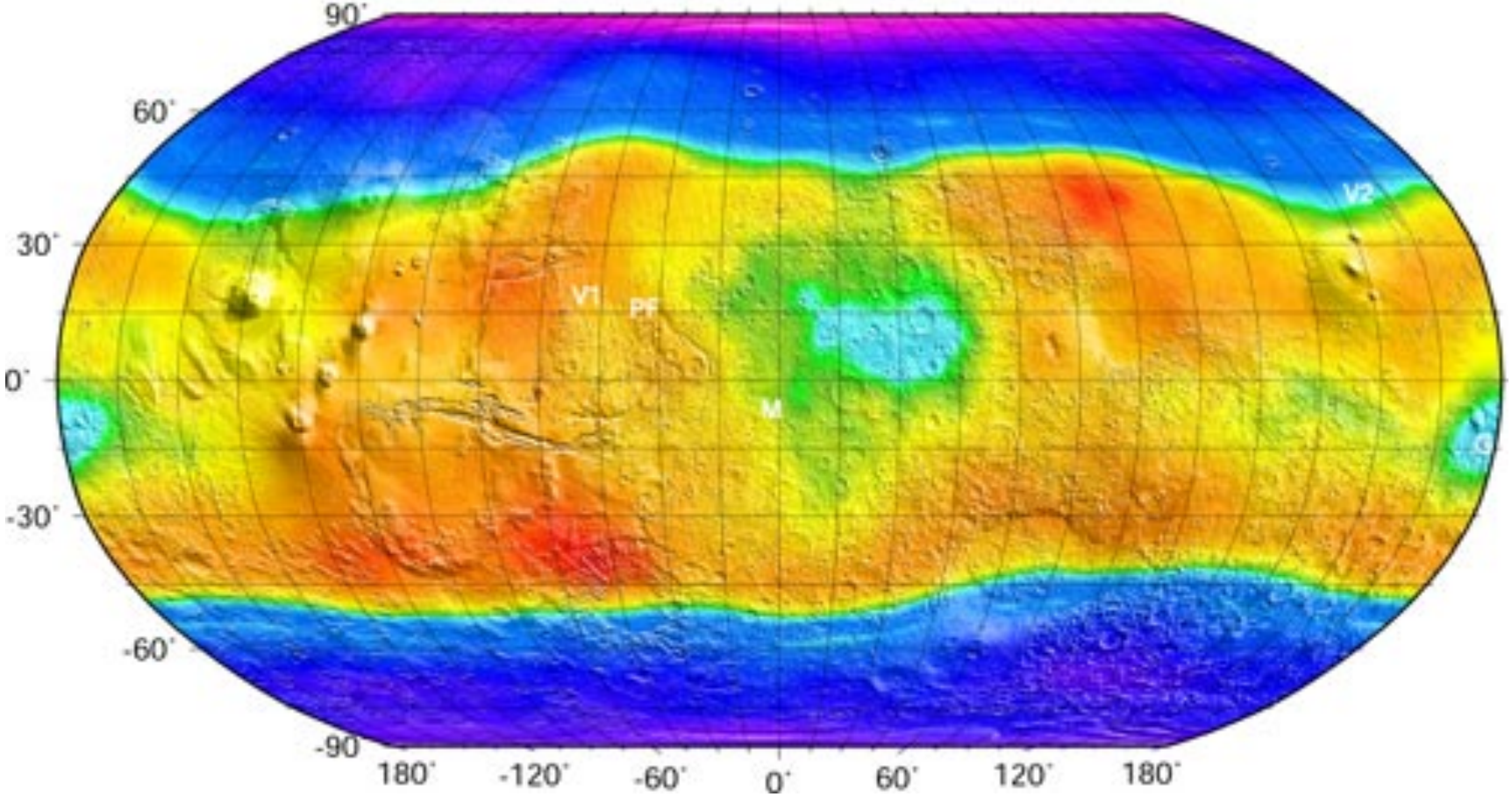
Answer:

- Excellent location for science to be done
- Resources available but not easily attainable

WATER MAP

2001 Mars Odyssey Gamma Ray Spectrometer

H2O Low H2O High



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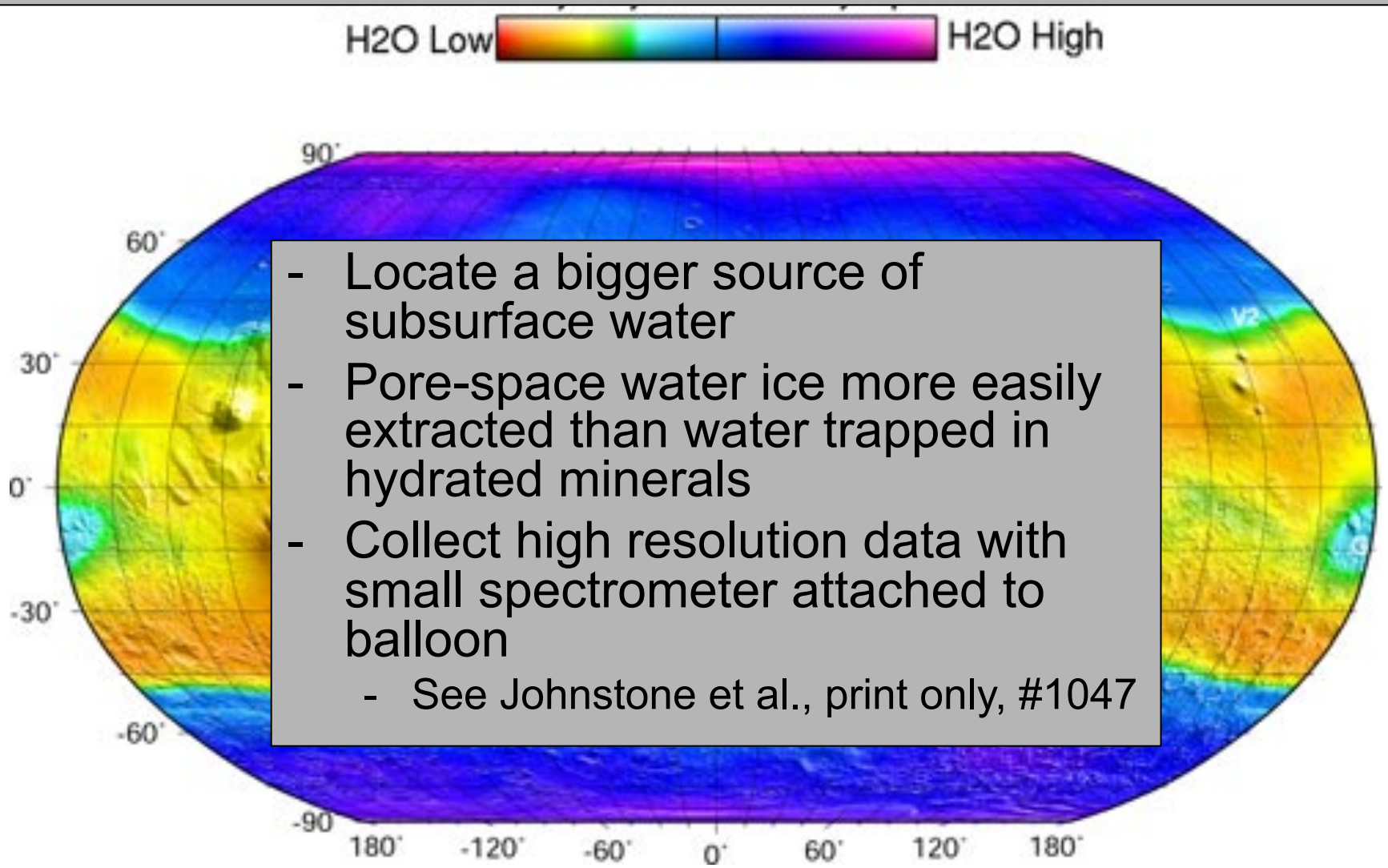
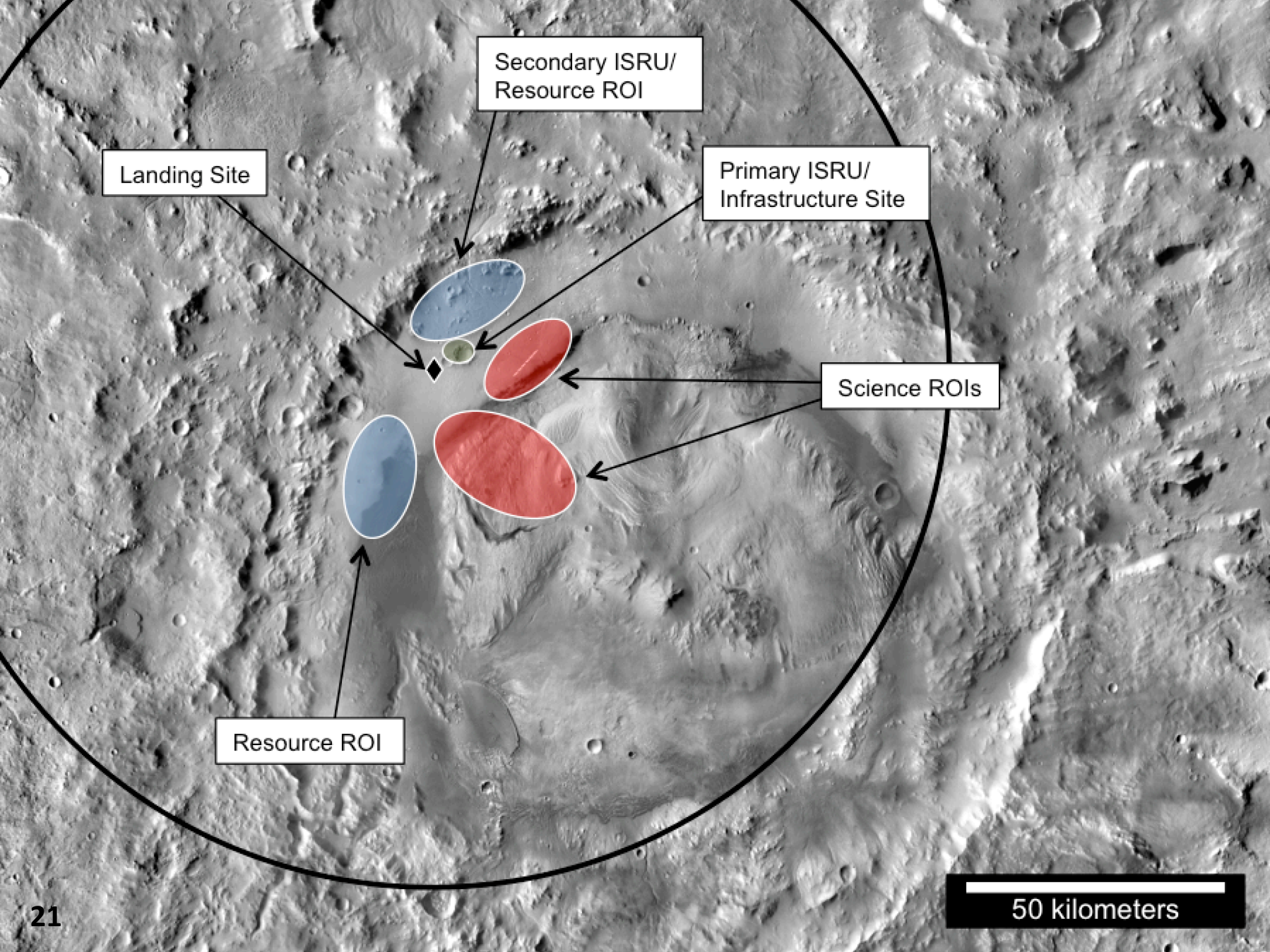
Gale Crater

Most important data set to collect: Neutron spectrometry at high resolution



- Locate a bigger source of subsurface water
- Pore-space water ice more easily extracted than water trapped in hydrated minerals
- Collect high resolution data with small spectrometer attached to balloon
  - See Johnstone et al., print only, #1047

Back Up


Secondary ISRU/
Resource ROI
Landing Site
Primary ISRU/
Infrastructure Site
Science ROIs
Resource ROI
50 kilometers

Tools

- Rover
- Building materials
- MSL experience and data set