Overview of Workshop:

- Completely Open Process
  - If you have something to say, say it
- Extremely full agenda
  - Rule presentation times with “iron fist”
  - Talks will be terminated if they run long
- Discussion of Science and Engineering
- Individual talks on proposed sites
  - Distributed in sessions by topic
  - Chaired by Steering Committee Members
- Discussion at end of each session
- Complete “Criteria Table” for each site

Current Engineering Constraints*

Engineering Parameter		Requirement	Notes
Latitude		45°N to 45°S	Sites poleward of 30°N have degraded EDL comm.
Elevation		≤ +1 km	MOLA-derived elevation
Landing ellipse radius and azimuth		≤ 12.5 km in the down-track direction; ~10 km in cross-track direction	Allowing for wind-induced uncertainty during parachute descent
Terrain Relief / Slopes	2 to 10 km length scale	≤ 20°	Radar spoofing in preparation for powered descent. *Also applies to "warning track" region.*
	1 to 2 km length scale	≤ 43 m relief at 1 km, linearly increasing to 720 m at 2 km	Radar spoofing in preparation for powered descent.
	200 to 1000 m length scale	≤ 43 m relief	Control authority and fuel consumption during powered descent
	2 to 5 m length scale	≤ 15°	Rover landing stability and trafficability in loose granular material
Rock height		≤ 0.55 m	Probability that a rock higher than 0.55 m occurs in a random sampled area of 4 m^2 should be less than 0.50%. Suggests low to moderate rock abundance.
Radar reflectivity		Ka band reflective	Adequate Ka band radar backscatter cross-section (> -20 dB and < 15 dB)
Load bearing surface		Not dominated by dust	Thermal inertia >100 J m^{-2} $s^{-0.5}$ K^{-1} and albedo <0.25; radar reflectivity >0.01 for load bearing bulk density
Surface winds for thermal environment		< 15 m/s (steady) < 30 m/s (gusts)	Constraints apply over all seasons and times of day, at 1 m above the surface. These constraints provide an environment in which the rover can perform science operations. *Also, steady winds must never exceed 40 m/s when the rover is non-operating (sleeping).*

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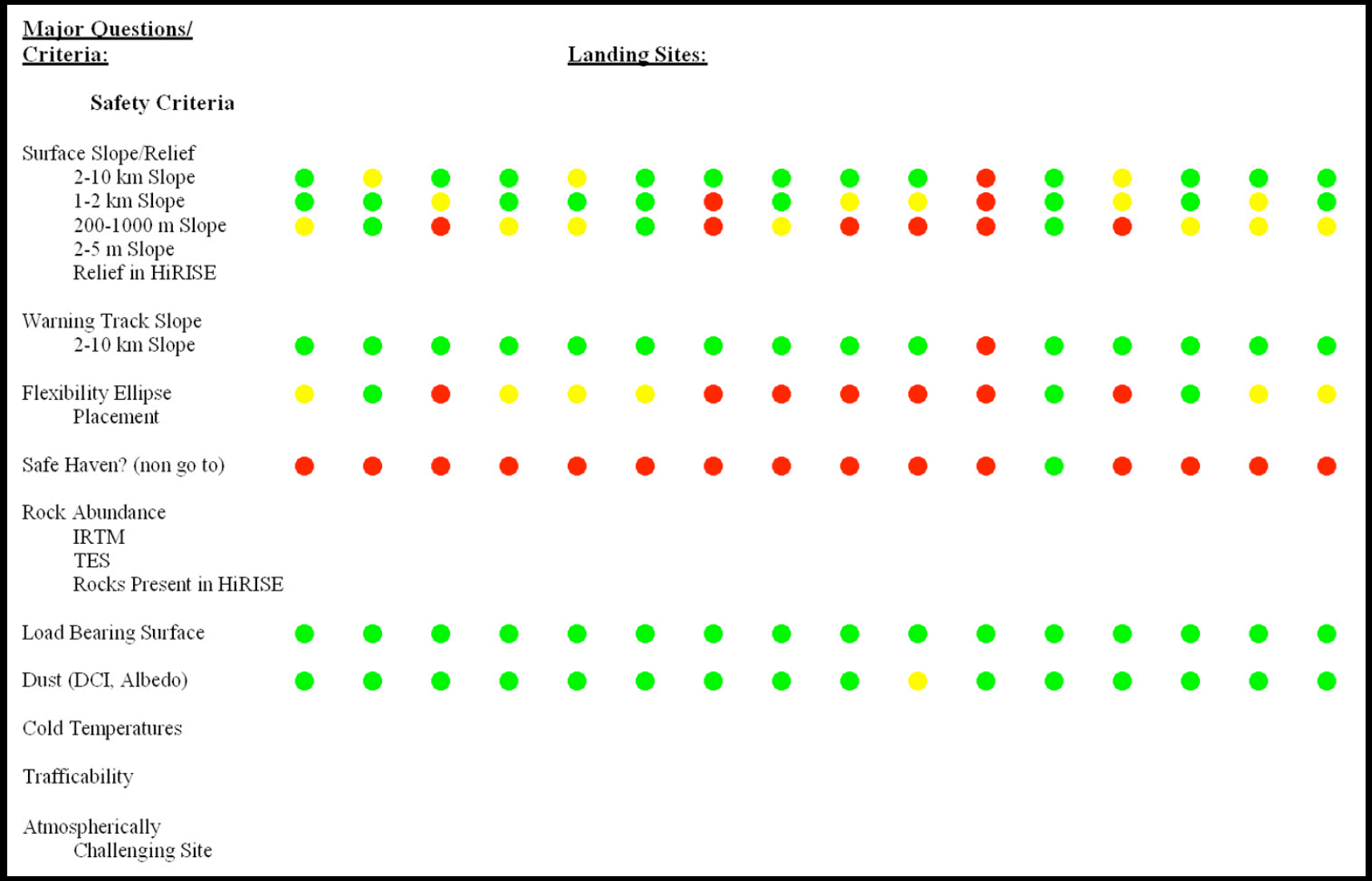
Completing Criteria Tables (I):

Summary MSL Landing Site Criteria

Major Questions/ Criteria:	Landing Sites:					
Science Criteria	**Nili Fossae**	**Holden**	**Terby**	**Mawrth**	**Eberswalde**	**Gale**
Ability to Assess Biological Potential w/MSL Payload						
Evidence for Habitable Environment (Environment of Formation and Deposition)						
Aqueous Environment, Type of Habitable Environment						
Preservation of Bio-Signatures						
Organic Material, (Pre) Biotic Materials, Biologic Textures, Mineralogic Biosignatures						
Ability to Characterize						
Geology/Geochemistry						
Context within Geologic Timescale						
Context within Geologic/ Geomorphic/ Stratigraphic Setting						
Accessibility						
Accessed by Rover/Arm						
Go To Distance/trafficability to Materials of Interest <1 km, <5 km, >10 km						
Dust Obscuration						
Reduced Performance Thermal Constraints						

Completing Criteria Tables (II):



Site Selection Timeline:

November 2005	**Preliminary Engineering Constraints Defined**
January 2006	**Announcement/Invitation to Workshop**
	Engineering constraints defined
	Science objectives defined
May 2006	**First Landing Site Workshop**
	Prioritize all sites for imaging by orbital assets
October 2007	**Second Landing Site Workshop**
	Select five sites (includes “havens”)
August 2008	**Third Landing Site Workshop**
	Recommend Landing Site Zone
June 2009	**Fourth Landing Site Workshop**
	Recommend final ellipse
September 2009	**Selection of actual landing ellipse**
	Based on project and program reviews, NASA HQ selection
October 2009	**Launch**

TBD

TBD

Summary of Workshop Deliverables:

- Did I mention time was tight?
- Completed “Criteria Table for each site
- Compare sites at end of workshop
  - Evaluate consistency and revise as needed
- Discuss and Evaluate Front Runners
- Discuss “safe” and “uber safe” havens
- Recommend Sites
  - Up to five science if also “safe” and “uber safe”
- Discuss distribution wrt latitude bands
- Steering Committee will complete unfinished tasks

MSL Landing Site Steering Committee Members:

Name	Affiliation
John Grant*	Smithsonian Institution
Matthew Golombek*	Jet Propulsion Laboratory
Ken Tanaka	USGS Flagstaff
Philip Christensen	Arizona State University
Dave Desmarais	NASA Ames Research Center
Doug Ming	NASA Johnson Space Center
Bruce Jakosky	University of Colorado
Michael Malin	Malin Space Science Systems
John Mustard	Brown University
Richard Morris	NASA Johnson Space Center
Timothy Parker	Jet Propulsion Laboratory
Roger Phillips	Washington University
John Grotzinger	Caltech
Rich Zurek	Jet Propulsion Laboratory
Dawn Sumner	UC Davis

* Co-chairs of the MSL Landing Site Steering Committee

Landing Site Imaging:

Stunning Contributions from MRO, Odyssey, MGS, and Mars Express Teams

- **Existing and new data will be used from the following missions to evaluate the proposed MSL Landing Sites:**
  - Existing MGS MOC, MOLA and TES data
  - New and existing Odyssey THEMIS data
  - New and existing Mars Express data (e.g. Omega and HRSC)
- **MRO Standardized Observations**
  - HiRISE: 10 km long, 6 km wide; CTX: 30 km^2, CRISM: 10 km^2
  - Initial survey mode, 1 set per site
  - More as appropriate for high priority sites as process develops
  - Addition of new sites (e.g. MRO discoveries)
- **Continue concentrated imaging of remaining sites after second landing site workshop (October 2007)**


Totally Amazing Data!

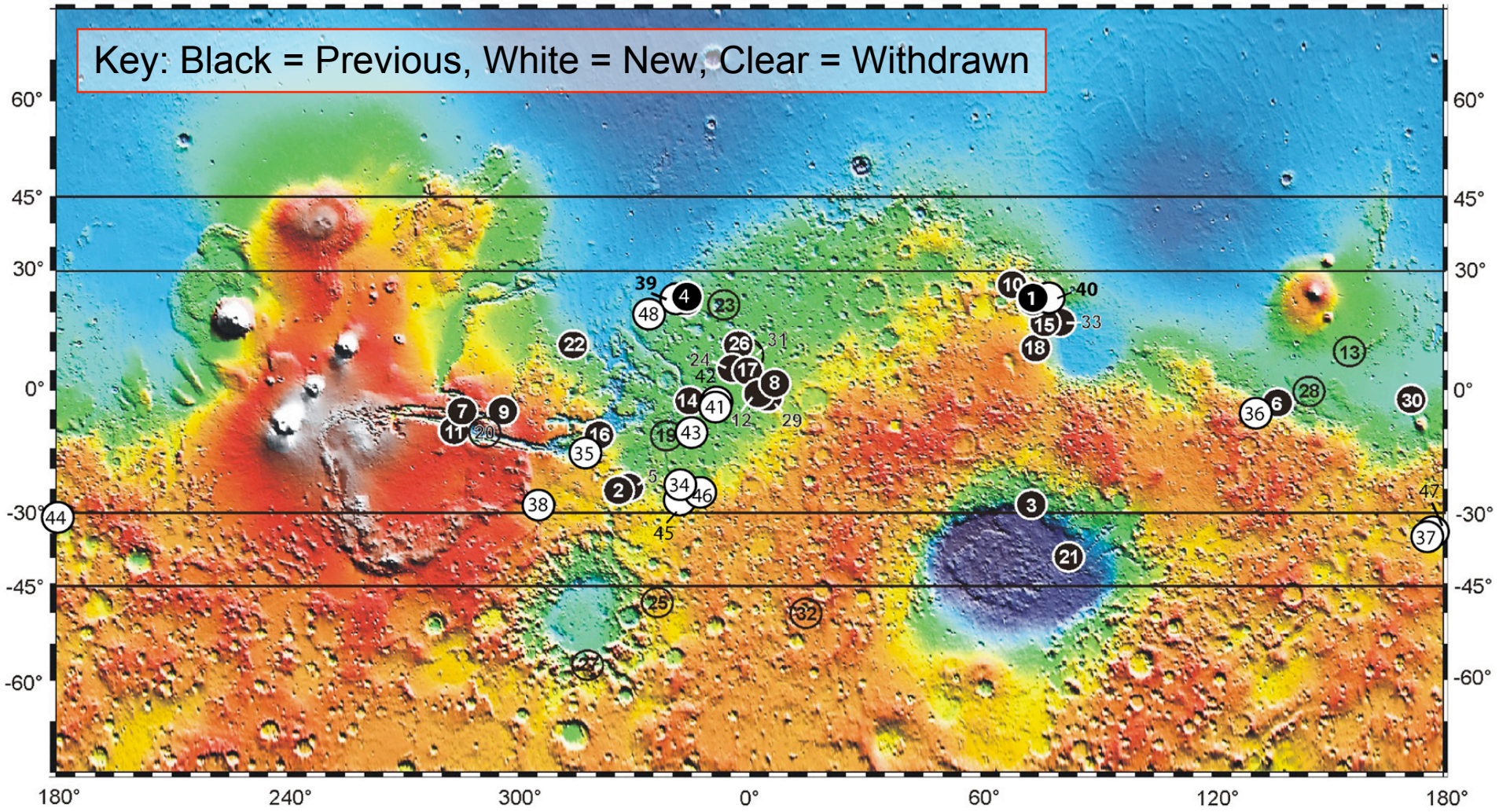
MRO Coverage of Sites:

http://marsoweb.nas.nasa.gov/landingsites/ and http://webgis.wr.usgs.gov/msl

NAME	HiRISE center lat (°N)	HiRISE center long (°E)	Obs ID	Complete?	HiRISE*	CRISM*	CTX*
Nili Fossae Trough	21.14	74.23	4001	Done	X	X	X
Holden Crater Fan	-26.44	325.23	3999	Done	X	X	X
Terby Crater	-27.57	74.22	3769	Done	X	X	X
Mawrth Vallis	24.90	340.20	9376	Done	X	X	X
Eberswalde Crater	-23.20	326.76	7094	Done	X	X	X
Gale Crater	-4.79	137.42	7034	Done	X	X	X
W Candor	-5.79	284.17	9377	Done	X	X	X
N Meridiani	2.37	6.69	3766	Done	X	X	X
Juventae Chasma	-4.53	297.87	9379	Done	X	X	X
Nilo Syrtis	29.30	73.28	4002	Done	X	X	X
Melas Chasma	-9.81	283.62	3997	Done	X	X	X
E Meridiani	0.04	3.63	3765	Done	X	X	X
Iani chaos	-2.06	342.41	7095	Done	X	X	X
Nili Fossae Crater	18.55	77.49	7096	Done	X	X	X
Eos Chasma	-10.72	321.92	3761	Done	X	X	X
Meridiani Crater Lake	5.47	358.14	7097	Done	X	X	X
NE Syrtis Major	16.46	76.58	7035	Done	X	X	X
Margaritifer Basin	-12.95	337.88	3998	Done	X	X	X
E Melas Chasma	-11.84	290.82	3757	Done	X	X	X
Hellas/Dao Vallis	-39.50	82.70	3752	Done	X	X	X
Xanthe/Hypanis Vallis	11.40	314.70	3753	Done	X	X	X
Becquerel Crater	21.32	352.52	3735	Done	X	X	X
SW Arabia Terra	5.68	355.63	3717	Done	X	X	X
W Arabia	8.90	358.95	9386	Done	X	X	X
W Meridiani	-1.70	352.39	7103	Done	X	X	
Elysium/Avernus Colles	-3.10	170.70	3754	Done	X	X	X
SML Craters	-49.16	14.51	3720	Done	X	X	
Isidis Basin Escarp	18.00	79.62	3755	Done	X	X	X

http://hirise.lpl.arizona.edu/science_themes/future_landing_1.php http://www.msss.com/msss_images/subject/mro_ctx.html http://crism.jhuapl.edu/msl_landing_sites/

Better Definition of Previously Proposed Sites and Identification of Potential New Sites



NUMBER	NAME	LOCATION	ELEVATION	TARGET	PRESENTER
1	Nili Fossae Trough*	20.93ºN, 74.35ºE	-0.6 km	Phyllosilicates	Jack Mustard
2	Holden Crater Fan	26.32ºS, 325.30ºE	-2.3 km	Layered Materials	Ross Irwin
3	Terby Crater*	27.7435°S, 74.1137°E	-5 km	Layered Materials	Sharon Wilson
4	Mawrth Vallis	24.65ºN, 340.1ºE	~-3.1 km	Phyllosilicates	Joe Michalski
5	Eberswalde Crater	23.85°S, 326.75°E	-1.4 km	Delta	J. Schieber
6	Gale Crater*	4.50°S, 137.35°E	-4.5 km	Interior Layered Deposits	Brad Thomson
7	W Candor*	5.80°S, 284.17°E	1.8 km	Sulfate Deposits	Scott Murchie
8	N Meridiani	2.37°N, 6.69°E	-1.5 km	Sedimentary Layers	Mike Malin
9	Juventae Chasma	4.45°S, 298.09°E	-2.8 km	Layered sulfates	Janice Bishop
10	Nilo Syrtis	29.16°N, 72.97°E	~-0.5 km	Phyllosilicates	Jack Mustard
11	Melas Chasma	9.81°S, 283.62°E	-1.9 km	Paleolake	John Grant
12	E Meridiani	0.01N°, 3.66°E	~-1.3 km	Sedimentary Layers	Brian Hynek
13	Athabasca Vallis	9.93N, 156.77°E	-2.4 km	Cerberus Rupes Deposits	Withdrawn
14	Iani Chaos	2.06°S , 342.41°E	Below -2 km	Hematite, sulfate	Tim Glotch
15	Nili Fossae Crater	18.44ºN, 77.58ºE	-2.6 km	Valley Networks, Delta Sediments	Caleb Fassett
16	Eos Chasma	10.7°S, 322.05°E	~-4 km	Chert	Vicky Hamilton
17	Meridiani Crater Lake	5.72°N, 358.03°E	~-1.5 km	Crater lake sediments	Liliya Posilova
18	NE Syrtis Major	~16.21ºN, ~76.63ºE	~1 km	Volcanics	Bethany Ehlmann
19	Margaritifer Basin	12.85ºS, 338.0ºE	-2.1 km	Fluvial Deposits	Withdrawn
20	E Melas Chasma	11.72°S, 290.72°E	Below -2 km	Interior Layered Deposits	Withdrawn
21	Hellas/Dao Vallis	39.5ºS, 82,7ºE	-6 km	Valley Terminus, Layered Deposits	Larry Crumpler
22	Xanthe/Hypanis Vallis	11.4ºN, 314.65ºE	-2.6 km	Layered Deposits	Larry Crumpler
23	Becquerel Crater	21.3°N, 352.52°E	-2.6 to -3.8 km	Layered Sedimentary Rocks	Withdrawn
24	SW Arabia Terra	6.01°N, 355.60°E	-1 km	Sedimentary rocks, methane	Carlton Allen
25	Gullies/Wirtz Crater	48.8°S, 335°E	-2.4 km	Gullies	Withdrawn
26	W Arabia	8.45°N, 359.09°E	-1.2 km	Sedimentary Rocks	Linda Kah
27	Argyre	56.8ºS, 317.7ºE	-1.5 km	Glacial Features	Withdrawn
28	NW Slope Valleys	~0, 145°E	~-2 km	Flood Features	Withdrawn
29	W Meridiani	1.7°S, 352.39°E	~-1.0 to -1.5 km	Sediments, Hematite	Horton Newsom
30	Elysium/Avernus Colles	3.05ºS, 170.60ºE	-2.5 km	High iron abundance	Larry Crumpler
31	Meridiani Bench	7.5ºN, 354ºE	~-1 to -1.5 km	Layered Sediments	Withdrawn
32	SML Craters	49.03°S, 14.494°E	Above -0.5 km	Recent Climate Deposits	Withdrawn
33	Isidis Basin Escarp	18.00ºN, 79.60ºE	-3.5 km	Volatile Sink	

Landing Sites added after 1st workshop

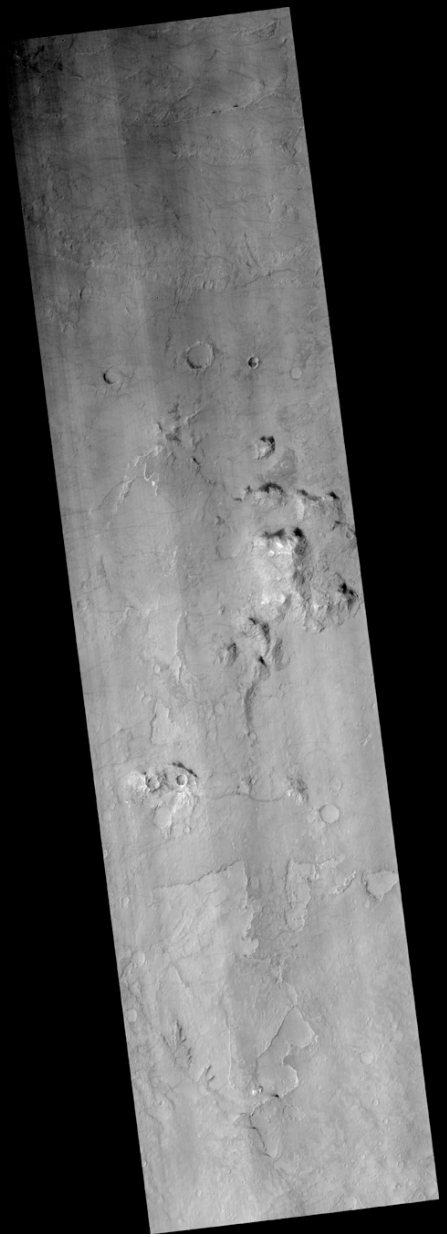
NUMBER	NAME	LOCATION	ELEVATION	TARGET	PRESENTER
34	Samara Vallis	23.55°S, 339.75°E	-1 km	Valley network channel	Mitrofanov
35	Eos Alluvial	13.6°S, 317.5°E	-3.5 km	Alluvial fan	Mitrofanov
36	Aeolis Fan Delta	5.05°S, 132.85°E	-2.2 km	Fan, delta	Mitrofanov
37	Ariadnes Colles	35.03°S, 174.17°E	-0.07 km	Clay-bearing outcrops	Eldar Noe
38	Ritchey Crater	28.28°S, 308.93°E	-1.18 km	Clays, Fan deposit	Ralph Milliken
39	Mawrth Vallis	24.5°N, 338.9°E 23.95°N, 341.2°E 23.2°N, 342.5°E	-3.08 km -2.22 km -2.10 km	Layered clays	J-P. Bibring
40	Nili Fossae	21.8°N, 78.6°E	-1.16 km	Clays, mafics	Nicolas Mangold
41	S. Meridiani Clays	3.35°S, 352.64°E	-1.95 km	Clays, sulfates	Selby Cull
42	W. Meridiani 2	3.01°S, 352.1°E	-1.88 km	Clays, sulfates	
43	Chloride Site 1	11.4°S, 343.4°E	-1.47 km	Chloride salts	Phil Christensen
44	Chloride Site 2	31.5°S, 180.8°E	1.39 km	Chloride salts	Phil Christensen
45	Chloride Site 3	27.9°S, 339.1°E	-0.04 km	Chloride salts	Phil Christensen
46	Chloride Site 4	25.4°S, 346.6°E	-0.04 km	Chloride salts	Phil Christensen
47	Chloride Site 5	34.36°S, 177.76°E	1.37 km	Chloride salts	Phil Christensen
48	Tiu Valles	22.9°N, 327.65°E	~ < -3.0 km	Chemolithotrophic habitat	Felipe Gómez
49	Meridiani Sites				J-P. Bibring

Busy Little Bees:

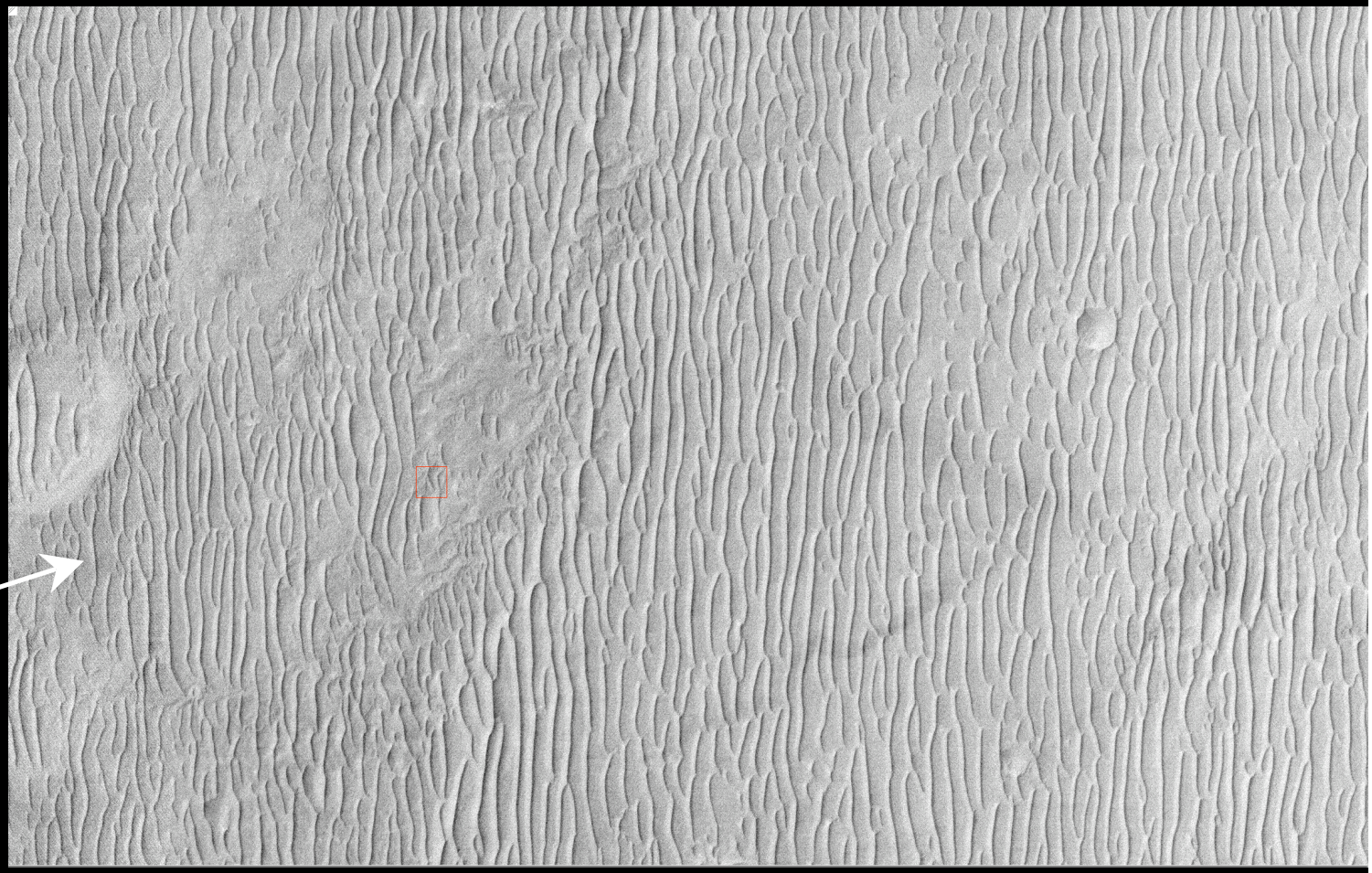
- First Cut at Engineering Constraints
  - Not set in stone
  - Ensures Completion
  - Uniform initial treatment
- Hazard Mapping
  - Using HiRISE images
- Complete “Criteria Table” for each site
  - Need to discuss in light of above

Holden Crater: PSP_005411_1535

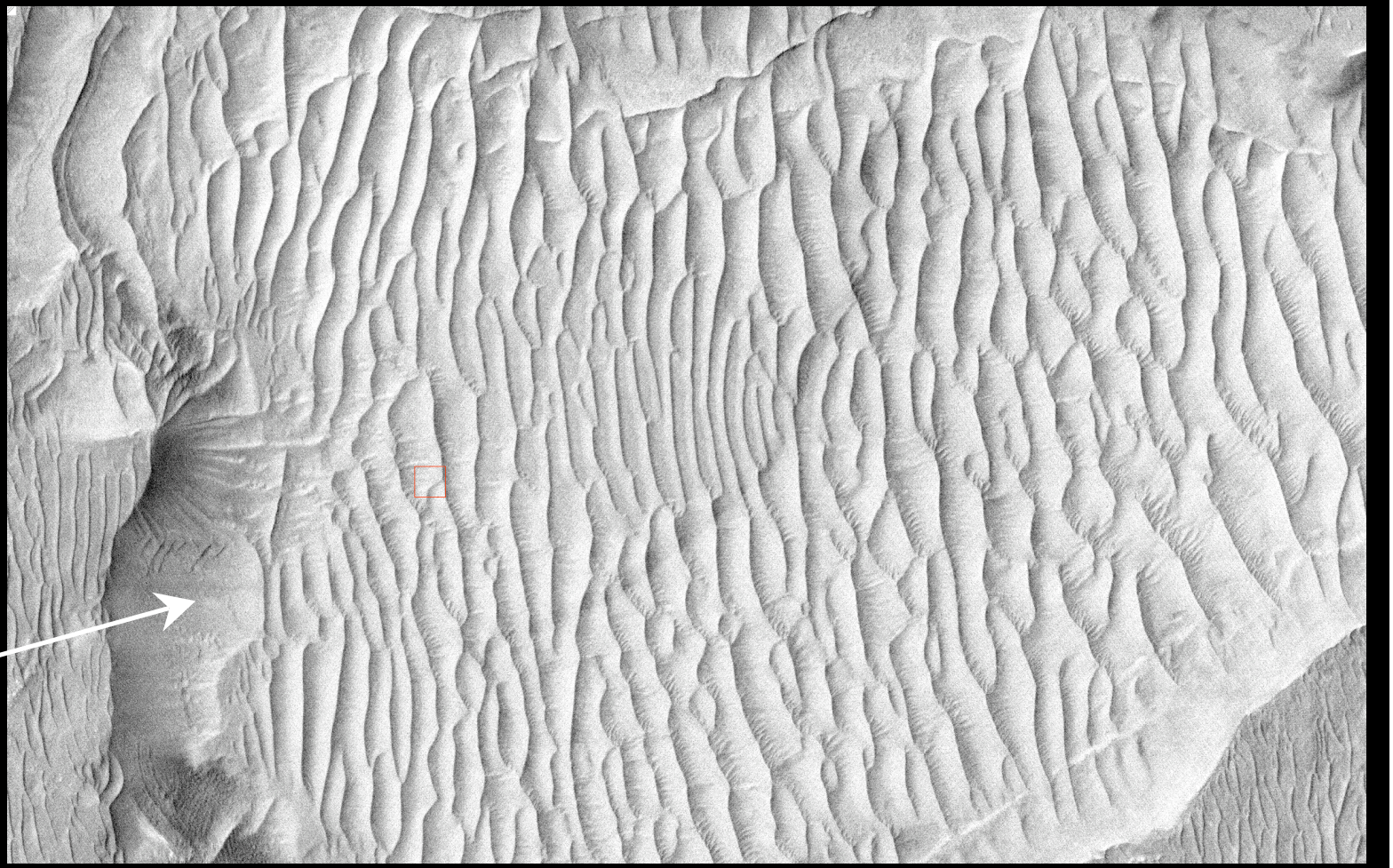
- Few to no rocks on plains, lots of ripples
- Some rocks on mounds (red/yellow areas in map on right)



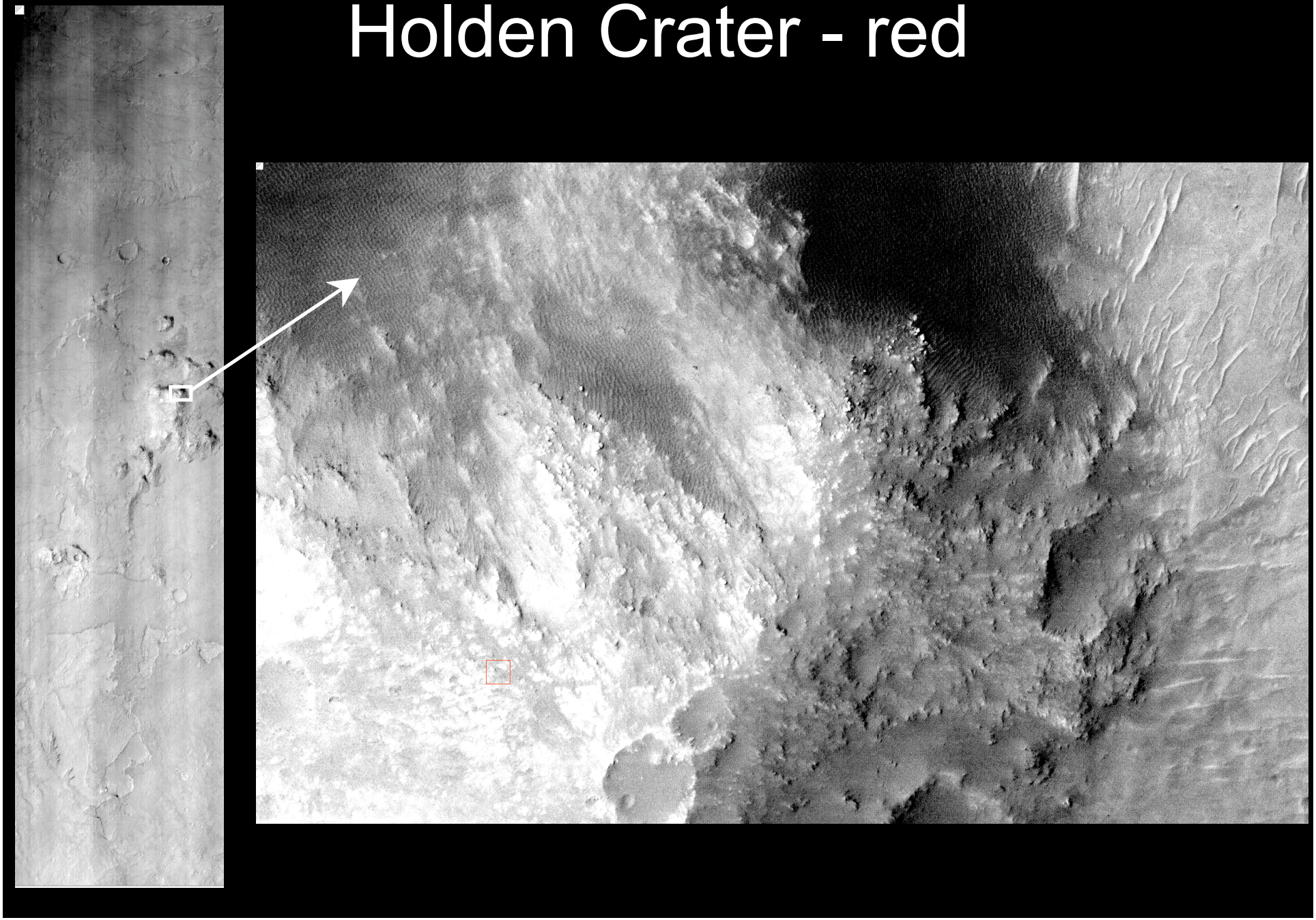
Holden Crater - green



Holden Crater - yellow



Holden Crater - red



Let’s Get Started!