Reprise of Day 1 activities
&
Overview of Mars Mission Concept Forum

(Revised based on in-meeting discussion)

Jeff Johnson, MEPAG Chair

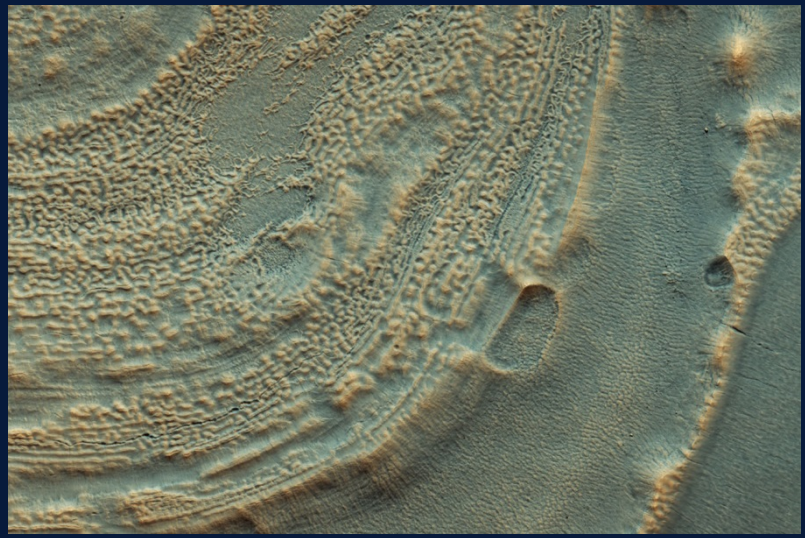
MEPAG Meeting 36, April 4

Agenda: Day 2

Decadal Survey Preparations			
08:15 AM	0:30	Reprise of Day 1 Activities	J. Johnson
08:45 AM	0:15	Planetary Protection	L. Pratt
09:00 AM	0:15	Planetary Exploration Science Technology Office (PESTO)	C. Mercer
09:15 AM	0:15	Status: Mid-term Decadal Survey Report	L. Prockter
09:30 AM	0:20	Decadal Survey Look-Ahead	D. Smith
09:50 AM	0:25	Break	
10:15 AM	0:30	MEP / Mars Sample Return (MSR) Science	M. Meyer
10:45 AM	0:20	Overview of Mars Mission Concepts Forum	J. Johnson
11:05 AM	0:20	Preparations for Decadal	J. Johnson
11:25 AM	1:00	Discussion	All
12:25 PM	1:00	LUNCH	
Reports from Mars Missions I			
01:25 PM	0:30	InSight	B. Banerdt
01:55 PM	0:30	MAVEN Results	B. Jakosky
02:25 PM	0:15	Mars Reconnaissance Orbiter (MRO) Results	L. Tamppari
02:40 PM	0:15	Mars Odyssey (ODY) Results	L. Kerber
02:55 PM	0:30	Break	
03:25 PM	0:30	Mars Moons Exploration (MMX) & MEGANE	D. Lawrence
03:55 PM	0:30	United Arab Emirates Mission to Mars	S. Amiri
04:25 PM	0:30	Mars Science Laboratory (MSL) Results	A. Vasavada
04:55 PM	0:20	Mars Exploration Rover (MER) Results	A. Fraeman
05:15 PM	0:20	Geodesy/Cartography, Phobos/Deimos Site Working Groups	T. Duxbury
05:35 PM	0:25	James Webb Space Telescope (JWST) and Mars	H. Hammel, S. Milam
06:00 PM	End of Day 2		

Summary of Day 1 Activities

Mars Exploration Program Reports			
08:15 AM	0:30	Welcome: Meeting Preview, MEPAG Updates	J. Johnson, MEPAG Chair
08:45 AM	0:30	NASA Planetary Science Division (PSD) Report	J. Green
09:15 AM	0:45	NASA: Mars Exploration Program (MEP) Status	J. Watzin
10:00 AM	0:15	Discussion	All
10:15 AM	0:15	Break	
Potential MEPAG Goals Revision: Polar Science			
10:30 AM	0:35	Polar Science Objectives & Investigations	I. Smith
11:05 AM	0:35	Evaluation by MEPAG Goals Committee	D. Banfield
11:40 AM	0:20	Discussion	All
12:00 PM	1:00	LUNCH	
Forum: Mission Concepts for the 2020's & beyond			
01:00 PM	0:20	Forum Introduction: Mission Concepts for next Decadal Survey	J. Johnson
01:20 PM	1:00	Poster "Lightning" Talks	Poster Presenters
02:20 PM	2:10	Mars Mission Concepts: Poster Session	All
04:30 PM	0:15	Break	
04:45 PM	1:00	Discussion: Paths to Next Decadal	J. Johnson lead
05:45 PM		End of Day 1	



Icy Layers in Craters
https://mars.nasa.gov/resources/21508/

Summary of Day 1 Activities (1 of 2)

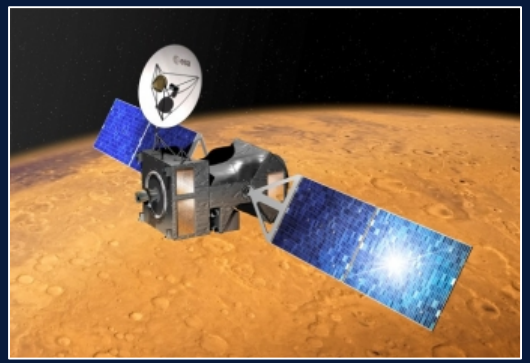
- **Planetary Science Division (PSD) Overview**
  - Good News: The increases in funding for the Planetary Science Division (including Mars in FY18) are welcomed; it's exciting to see the missions under consideration for the Outer Planets and for Mars
- **Mars Exploration Program (MEP) Overview**
  - Mars 2020 rover is on track and NASA is discussing and investing in how to accomplish the return of samples from Mars
  - NASA needs to follow through with the missions required without compromising the science

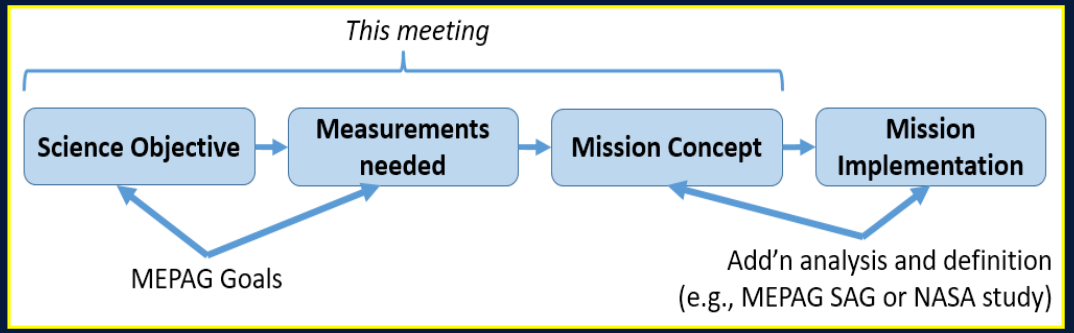
Summary of Day 1 Activities (2 of 2)

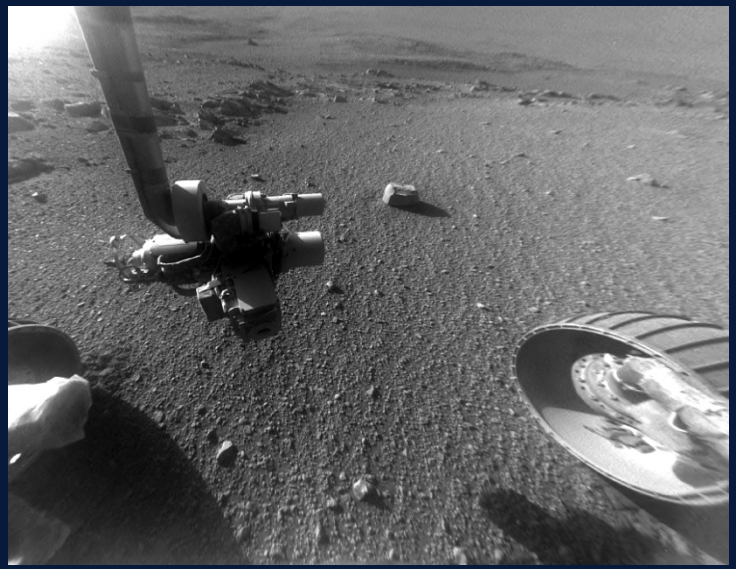
- **Mars Polar Science**
  - Suggested updates to Goals Document are in discussion with Goals Committee. Expect to open for community input/responses in June.
  - Next major update to Goals Document will happen after 9th Mars conference next summer

- **Mars Forum**
  - Which science questions appear to be addressable by technologies and spacecraft capabilities available in the coming decade?
  - Which high-priority areas could be addressed by NF class? By Discovery? By Small-Satellite?

Overview of Mars Mission Concepts Forum







Opportunity Views Ground Texture in 'Perseverance Valley'
Sol 4958 (Jan. 4, 2018)
https://mars.nasa.gov/resources/21499/

Preparing for the next Planetary Decadal Survey:

Building on discoveries of past/ongoing missions and new technologies

✓ The return of samples prepared by NASA's Mars 2020 rover continues to be a priority

- During the Mars Sample Return (MSR) era (~2023-2032) what are the additional high-priority science questions that could be addressed via mission concepts in all classes?

➢ Forum concept: Provide the community opportunities to discuss…

- High-level science objectives or questions
- Importance of specific types of observations/measurements/analyses
- Science or technology strategies (e.g., multiple small rovers or subsurface access)
- Mission concepts in all classes
  - ❑ Small satellite missions/secondary payloads enabled by strategic mission launch capabilities
  - ❑ Competed missions (Discovery, New Frontiers, Large strategic missions)
  - ❑ Follow-on flagship capabilities

❖ Goal of Forum: Identify concepts and collaboration opportunities for serious consideration by the next Planetary Decadal Survey

➢ Which would most benefit from studies/workshops organized by MEPAG or MEP to facilitate maturation of concepts and/or technological areas?

Preparing for the next Planetary Decadal Survey:

Focus Themes based on 31 submitted abstracts

- Ice/Polar studies (6)
- Modern/present surface and climate (10)
- Humans and astrobiology (6)
- Strategies from orbit/surface/subsurface (9)

Preparing for the next Planetary Decadal Survey:

Questions to be addressed within the Forum

1) What are the high-priority science questions that could be answered over the next two decades via Mars investigations?

2) What type of mission class(es) could be used to significantly address this science (in part or in full)?

3) Does addressing a particular science question (or a particular mission concept) fall into this next decade (2023-2032), or should we consider it more as a follow-on to MSR (which may still involve some work in the coming decade)?

4) Are there topics/questions that could be addressed by a MEPAG study or workshop, that would better enable a particular concept or class of concepts to be considered by the 2023-2032 Decadal Survey Committee?

Preparing for the next Planetary Decadal Survey:

Inputs from Forum

1) What are the high-priority science questions that could be answered over the next two decades via Mars investigations?

Ice/Polar (also see NEX-SAG discussions)

- How does the martian climate record connect to orbital variations, as evidenced by the surface and subsurface presence, distribution, and physical characteristics of polar and non-polar ice (including areas of excess ground ice)?
- To what degree can the past and present fluxes of volatiles, dust, and energy in the polar regions be constrained by an improved understanding of the cycling of water vapor, ice, CO2, dust, and aerosols and their effects on winds, accumulation/ablation rates of ice, and isotopic fractionation?
- What is the distribution and amount of ice present at depths of ~1-10m?

Preparing for the next Planetary Decadal Survey:

Inputs from Forum

1) What are the high-priority science questions that could be answered over the next two decades via Mars investigations?

Modern Surface and Climate (1 of 2)

- To what degree does the exchange of volatiles and energy between the surface and atmosphere affect the type, distribution, seasonality, and amount of CO2 deposition between poles and in non-polar icy regions?
- What improvements in Global Circulation Models are necessary to help refine global martian meteorology, including the influence of dust injection (from storms, polar jets) on the dynamics of dust and water ice?
- Over what timescales do surface process such as RSL formation, dust redistribution, and winds modify the martian surface?

Preparing for the next Planetary Decadal Survey:

Inputs from Forum

1) What are the high-priority science questions that could be answered over the next two decades via Mars investigations?

Modern Surface and Climate (2 of 2)

- What is climate record in the Amazonian over 10-1000 yr timescales?
- To what degree can the determination of water vapor, wind, and temperature vertical profiles improve knowledge of atmospheric dynamics and water cycling between ice and sub-surface reservoirs?
- How do trace gases such as methane vary temporally and spatially?
- What are the variations in D/H isotopic ratios across the planet?

Preparing for the next Planetary Decadal Survey:

Inputs from Forum

1) What are the high-priority science questions that could be answered over the next two decades via Mars investigations?

Humans and Astrobiology (1 of 2)

- What are the potential biosignatures in surface/subsurface ice-bearing materials?
- What are the health effects associated with exposure to the physical and chemical characteristics of true martian dust?
- What are the sampling handling protocols required to minimize contamination and improve preservation of returned samples?
- Are caves viable zones of exploration for humans?
- How well can local weather be monitored and predicted at human landing sites?

Preparing for the next Planetary Decadal Survey:

Inputs from Forum

1) What are the high-priority science questions that could be answered over the next two decades via Mars investigations?

Humans and Astrobiology (2 of 2)

- How can human landing sites be assessed for their science potential prior to determining/exploiting their in-situ resource utilization potential, and what are the planetary protection implications?
  - *cf. impending Planetary Protection policy report*

Preparing for the next Planetary Decadal Survey:

Inputs from Forum

1) What are the high-priority science questions that could be answered over the next two decades via Mars investigations?

Strategies from orbit/surface/subsurface (1 of 2)

- What are the absolute ages of volcanic rocks with known provenance and geologic context from a diverse suite of sampling locations?
- Where do subsurface regions exist with volatile reservoirs and which could be considered as habitable zones?
- What is the evolution of the martian interior, as evidence by seismicity, heat flow, crustal magnetic fields, and the magnetosphere?

Preparing for the next Planetary Decadal Survey:

Inputs from Forum

1) What are the high-priority science questions that could be answered over the next two decades via Mars investigations?

Strategies from orbit/surface/subsurface (2 of 2)

- What is the evolution of the martian atmosphere, as influenced by volatile cycling, chemistry, magnetic field strength, and obliquity cycle effects?
- How often and under what conditions are dynamic processes on the ground and atmosphere observed?
- What are the rock/mineral compositions and abundances of aqueously altered environments observed at high spatial resolutions?
- What is the history of climate/habitability change from pre-Noachian to today?

Preparing for the next Planetary Decadal Survey:

Inputs from Forum

2) What type of mission class(es) could be used to significantly address this science (in part or in full)?

Ice/Polar

- Small Sats:
  - Polar Drop (Hayne)
- Small/Medium competed:
  - M-PRESS (Discovery;Byrne)
  - Various sub-sets of science studied by NEX-SAG
  - Polar night condensation (Titus: advanced LiDAR, neutrons, bolometer)
- New Frontiers-class
  - **Orbital: NEX-SAG complement**
    Distribution and Origin of Ice Reservoirs
    - Sub-surface ice sounder and/or Synthetic Aperture Radar (SAR) imager
    - Current climate (weather, seasonal cap)
    - Imaging, SWIR, TIR mapping and/or sounding
    - Sub-mm for winds
  - **Landed**
    - Imaging, drill, rover

Preparing for the next Planetary Decadal Survey:

Inputs from Forum

2) What type of mission class(es) could be used to significantly address this science (in part or in full)?

Modern Surface and Climate

- Small Sats:
  - Global profile measurement of atmospheric temperature, dust, water ice, and water vapor, with surface temperatures at multiple times of day
  - Mars-synchronous (areosynchronous) orbit (Montabone)
  - Monitoring of polar regions for changes (jets)
- Small/Medium competed:
  - LIDAR (CO_2 vs. H_2O, grain sizes, ice thickness), SAR, neutron imaging, thermal emission spectrometer
  - Sub-mm sounder, a thermal infrared profiler, and a wide-angle camera using SEP
  - In situ observations from landers/rovers
- Note scalability of missions depending on size and number of instruments

Preparing for the next Planetary Decadal Survey:

Inputs from Forum

2) What type of mission class(es) could be used to significantly address this science (in part or in full)?

Humans and Astrobiology

- Small/medium competed missions
  - Icebreaker (Discovery 2015)
  - SAR for ice mapping (Kerber)
  - Airfall dust sample return
  - RSLs
  - Multiple MER class rovers for ISRU reconnaissance?

  - Challenge: Decadal Survey doesn't consider/prioritize human exploration, yet the concept of "dual purpose" missions (SMD/HEO) is of potential strategic interest

Preparing for the next Planetary Decadal Survey:

Inputs from Forum

2) What type of mission class(es) could be used to significantly address this science (in part or in full)?

Strategies from orbit/surface/subsurface

- Small Sats:
  - Dropped landers, hoppers, helicopters
  - Magnetometers
  - Sounders
- Small/Medium competed:
  - Next generation orbital remote sensing instrumentation
    - HiRISE 2, CRISM2, TES2, THEMIS2
  - Multi-point magnetic field, plasma and atmospheric escape measurements (Discovery class)
  - Multiple rovers or other multi-site spacecraft
  - Grab-and-go from well-characterized sites
    - Less expensive than full MSR but not “fully blind”

Preparing for the next Planetary Decadal Survey:

Inputs from Forum

3) Does addressing a particular science question (or a particular mission concept) fall into this next decade (2023-2032), or should we consider it more as a follow-on to MSR (which may still involve some work in the coming decade)?

- All submitted ideas could be pursued in the coming decade.
- The concept of maintaining our combined analyses of “Mars as a system” was a common theme.

Preparing for the next Planetary Decadal Survey:

Inputs from Forum

4) Are there topics/questions that could be addressed by a MEPAG study or workshop, that would better enable a particular concept or class of concepts to be considered by the 2023-2032 Decadal Survey Committee? (1 of 3)

- Power requirements for surviving Polar night with landed mission
- SAG to explore polar landed mission concepts, including stationary lander with polar/astrobiology drill and/or science accomplished from rover missions.
- Consider network Mars Drop SAG, one element of which is PolarDrop, among other possible science goals from stations at multiple locations.
  - Survivability of “drop-off” missions
- Team “X” studies of entire mission/systems, *with science as driver*
- Analysis of orbital entries/propulsion for Small Sats (Team “A”?), *with notional missions to define the requirements* (consult with PESTO)

Preparing for the next Planetary Decadal Survey:

Inputs from Forum

4) Are there topics/questions that could be addressed by a MEPAG study or workshop, that would better enable a particular concept or class of concepts to be considered by the 2023-2032 Decadal Survey Committee? (2 of 3)

- Analysis of dual-purpose instrumentation for humans and science while maintaining contamination protocols for both.
- How can the combination of orbital and landed assets be used to substantially improve ground truth, context, and overall mission science return?
- How do we constrain the current/predicted engineering capabilities of small spacecraft over the upcoming decade, and how can those constraints be used to provide realism to specific science objectives that would not otherwise consider small spacecraft as an option?

Preparing for the next Planetary Decadal Survey:

Inputs from Forum

4) Are there topics/questions that could be addressed by a MEPAG study or workshop, that would better enable a particular concept or class of concepts to be considered by the 2023-2032 Decadal Survey Committee? (3 of 3)

- Standardized “Mars CubeSat Bus” serving as release mechanism for several independent CubeSats, and subsequently operate as a telecommunication relay.
  - Avoids cubesats having to focus on interplanetary propulsion and direct-to-Earth telecommunication, which are the least scalable factors.

Generic Questions from discussions

- Where are the representatives from the sample science community in this process (or at this meeting)?
- Where are the Goal I- and Goal IV-related studies for small spacecraft?