Mars Exploration Program Analysis Group (MEPAG)

Welcome to MEPAG Meeting #36

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Jeffrey R. Johnson, MEPAG Chair

April 3-5, 2018

Crystal City, VA

Sol 1931
https://mars.jpl.nasa.gov/resources/21546/

Outline of Introductory Remarks

- Ground Rules and Goals for the meeting
- Overview of MEPAG
  - Background on committees, members
  - List of MEPAG activities since last virtual meeting (Feb. 20, 2018)
- Update and overview of agenda
- Encompassing concerns and reasons for optimism

Meeting Ground Rules

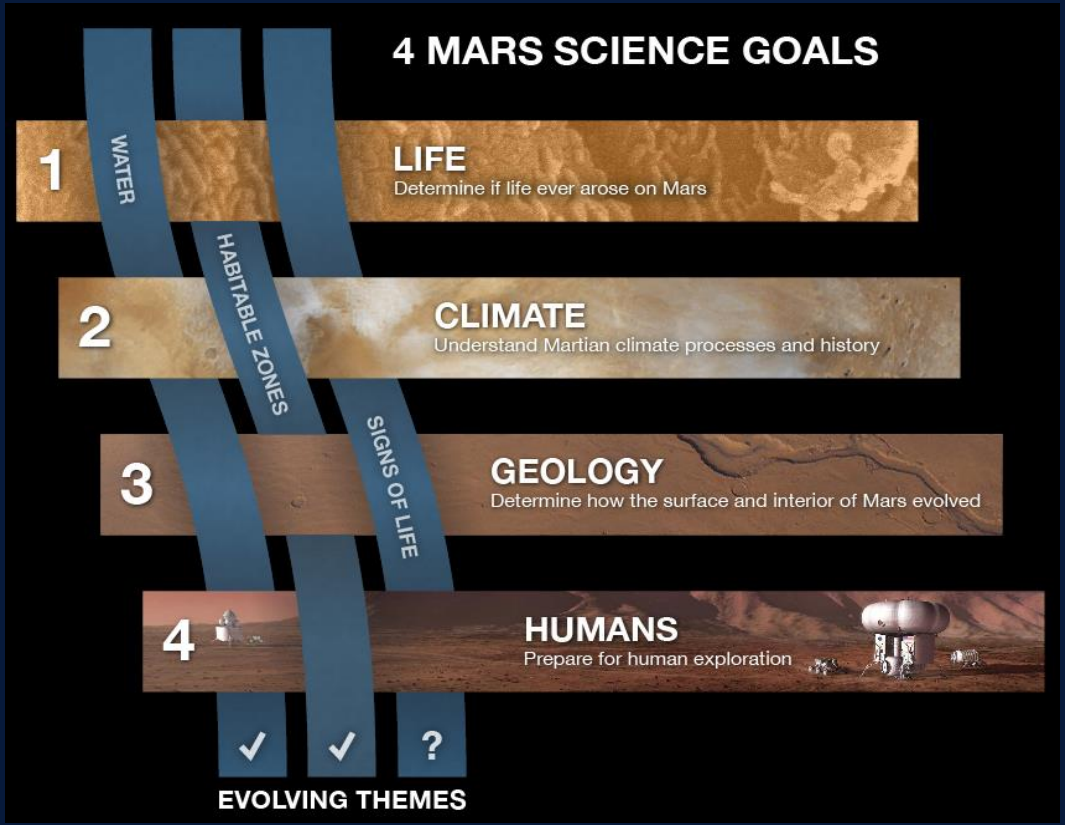
- Speakers will be kept on time according to the agenda
- Questions/comments from local audience?
  - Wait for microphone and state name/affiliation
- Questions/comments from remote audience?
  - Use chat box on Adobe Connect; moderators will track questions
  - Feedback/questions after meeting? → MEPAGmeetingqs@jpl.nasa.gov
- Presentations and Meeting summary notes (once cleared and waivered) will be made available on MEPAG website after ~April 15
  - Intend to develop Findings during the course of the meeting; will review at the end
  - These will be briefed to the Mars Exploration Program and, through the Planetary Science Advisory Committee (PAC), to the NASA Advisory Council (NAC)
  - Please do not take pictures of slides

- Goals of the Meeting
  - Receive updates from *and provide feedback to* NASA HQ and the Mars Exploration Program
  - Initiate preparations for next Planetary Decadal Survey (DS)
    - Forum: Identify concepts and collaboration opportunities for consideration by the next DS
    - Map out path to update the Goals Document
      - One step on that path is discussion of polar science strategies and proposed document changes
  - Receive updates from active and planned Mars missions
  - Discuss International and cross-Directorate activities
    - (e.g., Science Mission Directorate (SMD)-Human Exploration/Operations Mission Directorate (HEOMD))
  - Receive briefings on conferences, team reports, National Academy of Sciences (NAS) studies
  - Recommend actions to NASA HQ and Mars Exploration Program
    - Science Analysis Groups or other studies; Findings and Concerns

Mars Exploration Program Analysis Group (MEPAG)

*The **Mars Exploration Program** is an integrated program of robotic flight missions and research activities dedicated to:*

- *Understanding how Mars has evolved as a planet*
- *Whether there is evidence of life, past or present*
- *Preparations for future exploration by humans on Mars itself*



Can we determine if/when Mars was/is inhabited?

What is MEPAG?

https://mepag.jpl.nasa.gov/about.cfm

- MEPAG serves as a community-based, interdisciplinary forum for inquiry and analysis in support of Mars exploration objectives.
- MEPAG is responsible for providing science input needed to plan and prioritize Mars exploration activities.
- Meetings are open to all members of the planetary exploration community, particularly those scientists, engineers, project and program personnel, theoreticians and experimentalists, instrument scientists, and modelers who are interested in Mars exploration. International participation is welcomed and solicited as appropriate.

Curiosity reaching the southern part of Murray Buttes - sol 1435 - NASA/JPL-Caltech/MSSS/Thomas Appéré

What does MEPAG do?

- MEPAG maintains the Goals Document and conducts analysis activities on topics of relevance to Mars-related exploration. http://mepag.nasa.gov/reports.cfm
  - 4 Main Goals : 1) Life, 2) Climate, 3) Geology, 4) Preparation for Humans (not prioritized)
  - Prioritized Hierarchy within each Goal: Objectives, Sub-objectives, and Investigations
  - Cross-cutting and interdisciplinary themes identified and articulated
- Analysis tasks may be requested by NASA, including its Planetary Science Division, Mars Exploration Program (MEP), its Science and Human Exploration & Operations Mission Directorates (SMD, HEOMD), and its advisory committees, such as the Planetary Science Advisory Committee (PAC).
- Tasks may also be requested through NASA by committees of the National Academy of Sciences (NAS) Space Sciences Board. MEPAG may choose to organize Science Analysis Groups (SAGs) to deal with specific issues; these SAGs report their findings to the full community. Findings are reported to the requestors and posted to the community on the MEPAG website, and status reports are routinely made to MEP and PAC.
  - Note that MEPAG is *not* a formal part of the NASA advisory structure; the AG Chairs are routinely invited to report to the PAC

How is MEPAG organized?

- Chair: appointed by the MEPAG Executive Committee in consultation with NASA Headquarters.
- MEPAG Executive Committee : MEPAG Chair (lead), the previous MEPAG Chair, the MEP Lead Scientist, the Mars Program Office Chief Scientist, the Goals Committee Chair, and up to 5 additional members of the MEPAG community. HEOMD Chief Scientist for Exploration is an ex officio member.
- Goals Committee nominally has two members for each of the four goal areas, in addition to its Chair.
- Membership of the Executive and Goals Committees are solicited from the MEPAG community and determined by the Chair and Executive Committee.
- Typical terms ~2-3 years depending on activity
- Logistical and organizational support to the MEPAG, including its analysis groups, is provided through the Mars Program Office, located at the Jet Propulsion Laboratory.

MEPAG Committees

- Executive Committee (J. Johnson, Chair, appointed 3/16)
  - W. Calvin (Univ. Nevada Reno)
  - J. Eigenbrode (GSFC)
  - L. Pratt (NASA HQ) →*Planetary Protection Officer*
  - D. Banfield (Cornell)
  - S. Hubbard (Stanford University)
  - D. Beaty, R. Zurek (JPL)
  - M. Meyer (NASA HQ)
  - B. Bussey (HEOMD, NASA HQ) Ex Officio

- Goals Committee (D. Banfield, Chair)
  - Goal I *<Life>* (S.S. Johnson, Georgetown University; J. Stern, GSFC)
  - Goal II *<Climate>* (R. Wordsworth, Harvard University; D. Brain, Univ. Colorado; P. Withers, Boston Univ.)
  - Goal III *<Geology>* (S. Ruff, Arizona State University; A.Yingst, Planetary Science Institute)
  - Goal IV *<Human Exploration>* (J. Bleacher GSFC; R. Whitley, JSC)

Executive Committee

Jeff Johnson, Chair, JHU-APL

Lisa Pratt, Past Chair, NASA HQ

Wendy Calvin, UNR

Don Banfield, Goals Committee Chair, Cornell

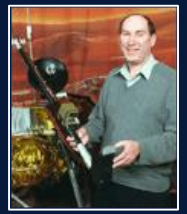
Scott Hubbard, Stanford

Jen Eigenbrode, GSFC

Dave Beaty, MPO/JPL

Michael Meyer, NASA HQ

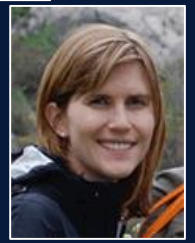
Ben Bussey, NASA HQ



Rich Zurek, MPO/JPL

Goals Committee

Jen Stern
NASA GSFC, Goal 1



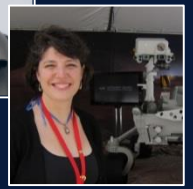
Sarah Stewart Johnson
Georgetown, Goal 1

David Brain
Univ. Colorado, Boulder
Goal 2

Paul Withers,
Boston University, Goal 2

Robin Wordsworth
Harvard University, Goal 2

Steve Ruff, ASU, Goal 3



R. Aileen Yingst, PSI, Goal 3

Don Banfield, Goals Committee Chair, Cornell

Ryan Whitley,
NASA JSC, Goal 4

Jacob Bleacher,
NASA GSFC, Goal 4

Recent MEPAG Meetings (https://mepag.jpl.nasa.gov/meetings.cfm)

- MEPAG #33: "Face-to-face" February 22-23, 2017 (Monrovia, CA)
  - https://mepag.jpl.nasa.gov/meeting/2017-03/Summary_MEPAG33_v5.pdf
- MEPAG #34: July 10, 2017 (Virtual meeting)
  - 2-hour telecon, including review/preview of presentations given to the Mid-Term Decadal Survey Review
  - https://mepag.jpl.nasa.gov/meeting/2017-07/MEPAG34_Summary_v4d.pdf
- MEPAG #35: September 25, 2017 (Virtual meeting)
  - 3-hour telecon, included NASA remarks on Mars architecture planning (J. Watzin), and presentations on Mars system Planetary Science Deep Space SmallSat Studies (PSDS3) projects from the PIs
  - https://mepag.jpl.nasa.gov/meeting/2017-09/MEPAG%2035%20Summary_final.pdf
- MEPAG VM #1: February 20, 2018 (Virtual meeting)
  - NASA MEP planning in the context of the released FY19 federal budget
  - Mars Sample Return technology studies from Chad Edwards (JPL Mars Program Office)
  - https://mepag.jpl.nasa.gov/meeting/2018-02/MEPAG%20VM1%20Notes%20v3.pdf

Recent MEPAG Activities since VM #1 (Feb. 20)

- Planetary Science Advisory Committee (PAC): Feb. 23, 2018
  - First meeting of new PAC, which replaced Planetary Science Subcommittee
    - Analysis/Advisory Groups (AGs) are no longer members of PAC
  - Presented in-person overview of MEPAG and recent activities, concerns:
    - https://smd-prod.s3.amazonaws.com/science-pink/s3fs-public/atoms/files/0-AGs-MEPAG%20Report%20to%20PAC%2002-2018_v02_0.pdf

- MEPAG abstract/poster at LPSC on future planning/schedule:
  - https://www.hou.usra.edu/meetings/lpsc2018/eposter/2403.pdf

- MEPAG "Meet & Greet" at LPSC: March 22, 2018 (12:00 to 1:15pm)
  - 15-20 visitors (in addition to 9 MEPAG members)

MEPAG Meeting #36

Agenda: Day 1

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	

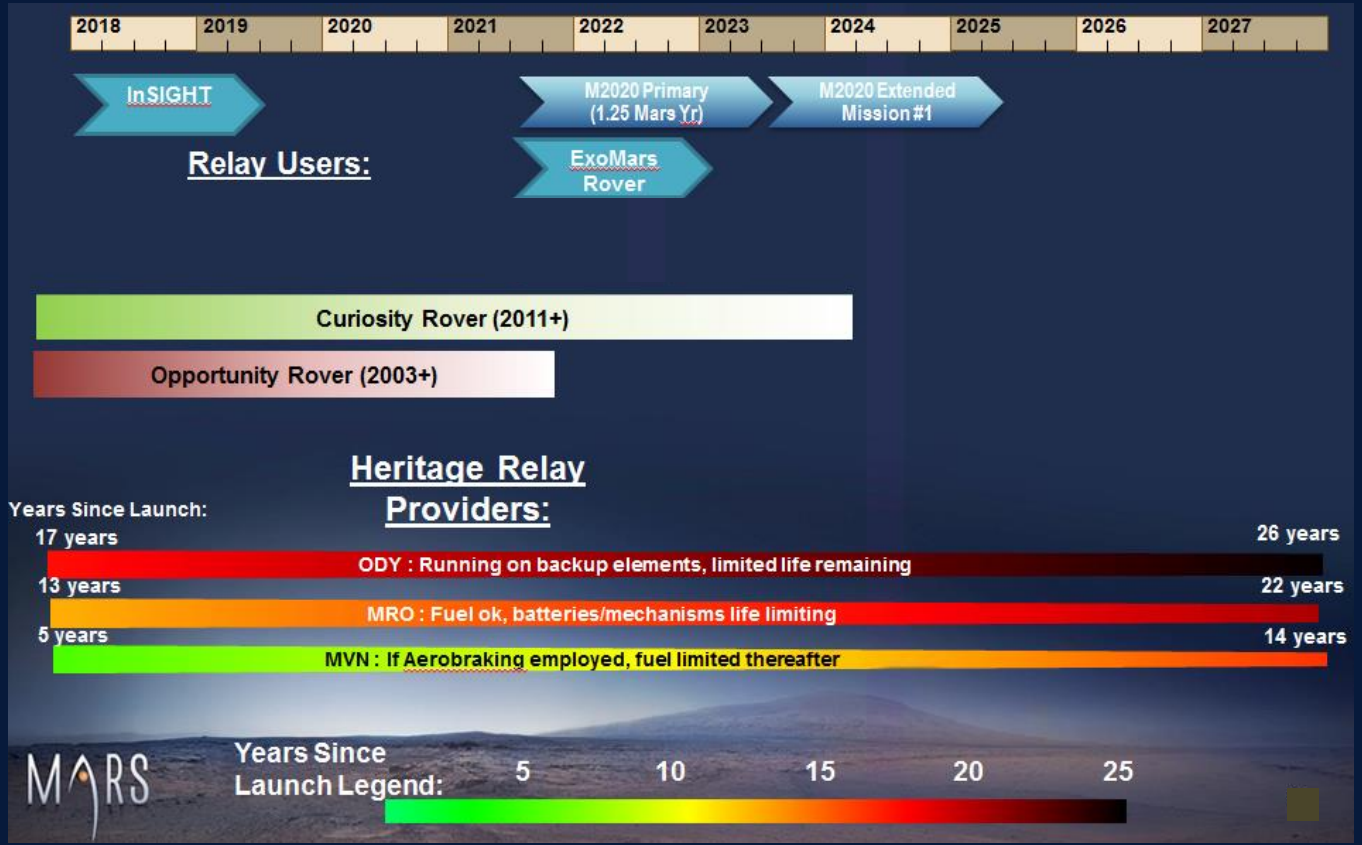
Agenda: Day 2

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		

Agenda: Day 3

Reports from Mars Missions II			
08:00 AM	0:20	Mars Express (MEx)	D. Titov (remote)
08:20 AM	1:00	ExoMars: TGO & 2020 Rover	J. Vago
09:20 AM	1:00	2020 Rover	K. Farley
10:20 AM	0:15	Break	
Human Exploration & Commercial Space			
10:35 AM	0:10	Science Mission Directorate (SMD): Looking ahead to Mars Human Exploration	R. Davis
10:45 AM	0:20	Martian Subsurface Ice Science Investigation	J. Eigenbrode
11:05 AM	0:20	HEOMD & Mars missions: Status	N. Suzuki
11:25 AM	0:20	Architecting Mars V (AM-V) Report	J. Connolly
11:45 AM	1:15	LUNCH, MEPAG Executive Committee Tag-up	
Conference/Team Reports			
01:00 PM	0:20	4th Early Mars Conference	S. Clifford (remote)
01:20 PM	0:20	Small Spacecraft Programs	C. Mercer
01:40 PM	0:15	COSPAR Preparations	D. Beaty, L. Tamppari
01:55 PM	0:20	Mapping and Planetary Spatial Infrastructure Team (MAPSIT)	J. Skinner
Concluding Section: Actions			
02:15 PM	0:45	Potential Study Groups/SAGs, Wrap-Up	J. Johnson
03:00 PM		Adjourn	

MEPAG Concerns: 1--MEP Infrastructure is Nearing Exhaustion



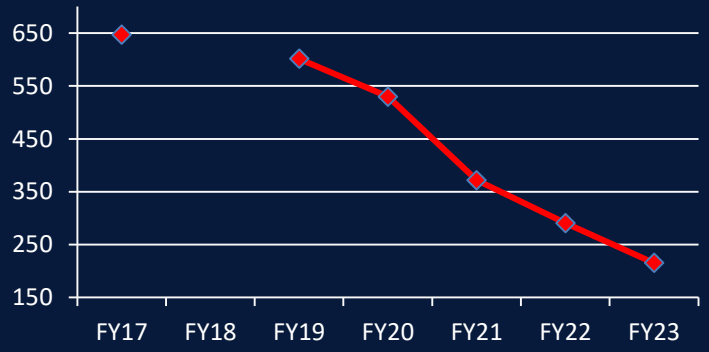
Should include Mars Express and Trace Gas Orbiter as possible relay providers as well

MEPAG Concerns: 2

- A prime concern of the MEPAG community has been the absence of high-level commitment to missions needed to carry out the return of the samples to be collected by 2020 caching rover now in development.
  - For a time, NASA avoided even discussion of such return. That changed with Dr. Zurbuchen's presentation to the Mid-Term Decadal Committee (August, 2017)
  - However, the FY19 President's Budget only "studies a potential Mars Sample Return"
- A second major concern of the U.S. portion of the MEPAG community is the absence of flight opportunities for U.S. investigators to address outstanding questions in Mars science *in parallel with, or perhaps as part of*, the orbiter and rover missions required for sample return.

MEPAG Concerns 3: Mars Notional Budget for FY19+

	Actual FY 17	Enacted FY 18	Request FY 19	Notional FY 20	FY 21	FY 22	FY 23
Science	5,762.2		5,895.0	5,859.9	5,841.1	5,822.4	5,803.6
Planetary Science	1,827.5		2,234.7	2,199.6	2,180.8	2,162.1	2,143.3
Planetary Science Research	230.1		258.0	247.6	247.6	247.6	247.6
Planetary Defense	60.0		150.0	150.0	150.0	150.0	150.0
Lunar Discovery and Exploration	19.0		218.0	218.0	218.0	218.0	218.0
Discovery	194.6		381.2	476.6	375.0	355.6	348.5
New Frontiers	134.0		130.2	163.7	245.0	327.6	388.4
Mars Exploration	647.0		601.5	529.7	371.9	290.8	215.3
Outer Planets and Ocean Worlds	359.5		285.6	213.8	373.3	372.5	375.5
Technology	183.3		210.2	200.2	200.0	200.0	200.0



- Current Mars Exploration line reflects the roll-off of Mars 2020 build
- Definition of the next Mars architecture is required to reverse this trend
  - Next components of Mars Sample Return
  - Additional missions to address high-priority science questions

MEPAG Concerns 4: Mars Extended Mission budgets

FY 2019 President's Budget Estimates: NASA (P. 415, PS-69)

FY 2019 Budget

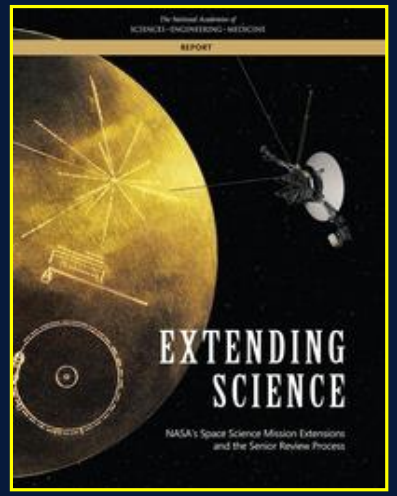
Budget Authority (in $ millions)	Actual FY 2017	CR FY 2018	Request FY 2019	Notional FY 2020	FY 2021	FY 2022	FY 2023
Mars Organic Molecule Analyzer (MOMA)	12.1	--	**8.5**	6.7	6.9	6.0	6.0
Aeroscience Ground Test Capabilities	14.6	--	**21.5**	22.2	22.2	22.2	22.2
ExoMars	2.2	--	**2.3**	2.1	2.2	0.0	0.0
Mars Program Management	24.2	--	**19.8**	19.8	20.0	13.7	15.3
Mars Future Missions	20.0	--	**50.0**	50.0	50.0	50.0	50.0
Mars Mission Operations	1.9	--	**1.9**	1.9	1.9	1.9	1.9
Mars Research and Analysis	10.0	--	**10.0**	10.0	10.0	10.0	10.0
Mars Technology	22.9	--	**8.5**	4.0	4.5	4.5	4.5
2011 Mars Science Lab	56.2	--	**54.0**	54.0	50.0	0.0	0.0
Mars Reconnaissance Orbiter 2005 (MRO)	28.0	--	**27.0**	27.0	26.0	26.0	25.0
Mars Exploration Rover 2003	12.5	--	**12.0**	0.0	0.0	0.0	0.0
Mars Odyssey 2001	10.8	--	**11.5**	11.5	0.0	0.0	0.0
Mars Express	3.0	--	**3.0**	0.0	0.0	0.0	0.0
Mars Atmosphere & Volatile EvolutioN	20.5	--	**23.5**	23.5	23.5	23.5	20.0
Total Budget	**239.0**	**--**	**253.5**	**232.7**	**217.1**	**157.8**	**154.9**

- Profile for Extended Missions' budgets is not consistent with recommendations from NAS study
  - They recommended at least flat funding after first two Senior Reviews for a mission
  - MRO, ODY, and MAVEN are required for Mars 2020 Rover relay and beyond

Extending Science: NASA's Space Science Mission Extensions and the Senior Review Process (p. 59)

Finding: After the first few years of extended operations, most missions have implemented all (or almost all) practical steps to reduce costs. Further budget cuts often then result in disproportionate cuts to project-funded science activities, increasing risks that science will be diminished or not performed at all.

Recommendation: Given the demonstrated science return from extended missions, NASA should continue to recognize their scientific importance and, subject to assessments and recommendations from the Senior Reviews, ensure that, after the first two Senior Reviews, both operations and science for high-performing missions are funded at roughly constant levels, including adjustments for inflation.



- https://www.nap.edu/download/23624
- http://sites.nationalacademies.org/SSB/CurrentProjects/SSB_169078

MEPAG Reasons for Optimism

- NASA has emerged from their restrictions on discussion about completing MSR
  - The concept of “lean-sample return” as described should help accelerate the return of samples from Mars
  - But it is important that the fundamental science requirements (e.g., number of samples) are not compromised
- Modest technology investments in Mars Ascent Vehicle and in techniques for the Rendezvous & Capture of the orbiting sample (OS) cache are making progress
  - See J. Watzin presentation, and MEPAG #35 presentation from Chad Edwards (slide 12)
- President’s budget includes $50M to study/define the remaining elements of MSR
  - Testing of the MAV rocket motors, retire technical risks
  - Techniques for breaking the chain of possible back contamination when capturing the Orbiting Sample cache
  - Establish the overall cost envelope for the “lean” sample return campaign approach
- Discussions with potential international and commercial partners are ongoing
  - Possible collaboration/partnering on Surface Return Lander (SRL, “fetch rover”) and/or Sample Return Orbiter (SRO) detailed studies