



MEPAG Report to Committee on Astrobiology and Planetary Sciences

R Aileen Yingst, Chair

29 September 2022



Mars Exploration Program Analysis Group (MEPAG)

MEPAG Programmatics

– Steering Committee (Chair: R. Aileen Yingst (PSI), appointed June 2019)

- V. Hamilton (Vice Chair, SWRI)
- W. Calvin (Univ. Nevada Reno)
- B. Horgan (Purdue)
- D. Banfield (Cornell)
- J. Filiberto (LPI; IDEA representative)
- C Dundas (USGS)
- S. Hubbard (Stanford University)
- S.S. Johnson (Georgetown University)
- K. Lynch (LPI; IDEA representative)
- M. Meyer (NASA HQ)
- D. Beaty, R. Zurek, M. Mischna (JPL)
- J. Bleacher/P. Niles (HEOMD, NASA HQ) Ex Officio members

– Goals Committee (D. Banfield, Chair)

- Goal I <Life> (J. Stern, GSFC; A. Davila, ARC)
- Goal II <Climate> (D. Brain (Univ. Colorado), Claire Newman (Aeolis Research))
- Goal III <Geology> (C. Viviano, APL, Becky Williams, PSI)
- Goal IV <Human Exploration> (J. Bleacher, NASA HQ HEOMD; M. Rucker, P. Niles JSC)



Recent MEPAG Activities since last CAPS (2019)



Recent MEPAG Activities since 2019

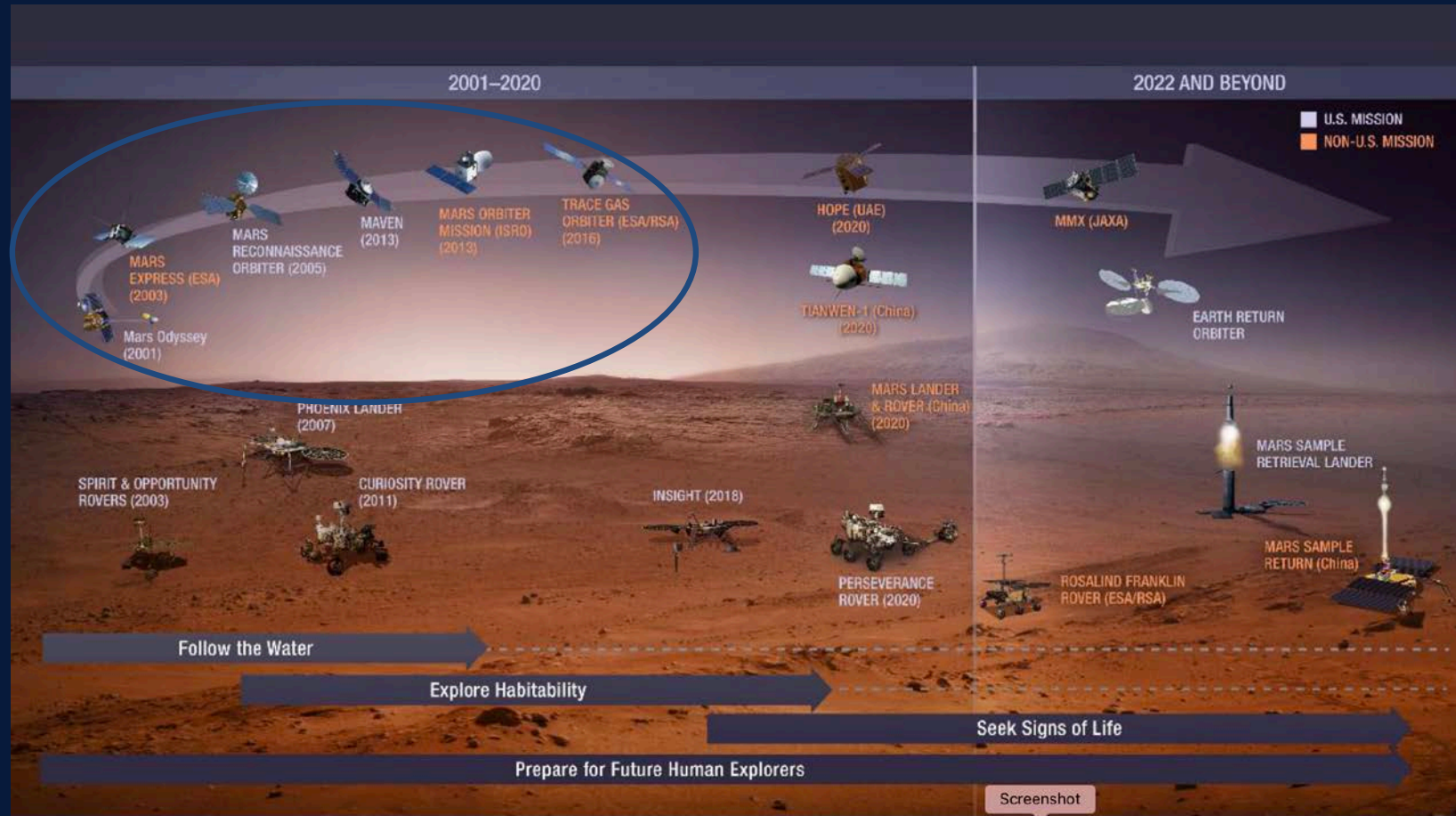
- Virtual Meetings

- VM6 [8/28/19]
- VM7 [11/13/19]
- VM8 [2/28/20]
- MEPAG 38th [4/15-17/20]
- VM9 [6/26/20]
- VM10 [10/20/20]
- VM11 [1/27/21]
- VM12 [6/21/21]
- VM13 [9/27/21]
- VM14 [2/2-3/22]
- MEPAG 39th [5/2-5/4]

- Important Issues

- MSR: Mid-term assessment; Launch/landing of M2020; IRB; SRR
- Mars exploration: MASWG; iMIM
- International: Tianwen; UAE Hope; ExoMars; JAXA
- NASA: EMs for Odyssey, MSL, MRO, MAVEN
- Orbital infrastructure: NO MOVEMENT
- Funding: FY21 budget debated, finally passed
- Decadal Survey: 7 white papers, 24 topical papers from MEPAG
- Transitions: (MEP) Jim Watzin > Eric Ianson; (MEPO) Fuk Li > Joe Parrish, R. Zurek > M. Mischna
- Access to Mars Surface workshop, Low cost Mars workshop, DEIA
- Decadal Survey outbrief, Science opportunities for next decade, ExoMars

Mars Exploration Program Analysis Group (MEPAG)



Discipline-Specific Issues Summary

- Major issues and concerns for Mars science are:
 - An aging infrastructure, both at Mars and on the ground (DSN)
 - Lack of identified opportunities for competed non-MSR flight investigations (especially small spacecraft, commercial and international partnerships)
 - The importance of continued basic R&A support for the current and next generation of scientists
 - The relationship between the human and robotic exploration programs and the roles of commercial and international partners are not always clear wrt the MEP.
 - *MEPAG continues to respond to calls for assistance with planning and analysis (MCE-SAG, response to Humans at Mars workshop).*



Important MEPAG Activities 2020-2022

- Science Analysis Groups and Definition Teams
 - MCE-SAG (Mars Concurrent Exploration-Science Analysis Group –report to be released end of 2022)
 - i-MIM MDT
- Goals Document
 - Last update released March, 2020 - for support of Decadal Survey
- MSR
 - Mid-term assessment
 - Launch/landing/operations of M2020
 - IRB; SRR
- Support of MEPAG community response to Decadal Survey
 - Seven white papers and 24 topical papers



Key outcomes of Decadal Survey for Mars

- **Top-level Mission Priority:** Mars Sample Return
- **Top-level Recommendation:** Continue coordinated Mars Exploration Program - restore to previous funding levels after peak spending on Mars Sample Return
- **Key Recommended Elements of the Mars Exploration Program**
 - Continue support for extended missions, new missions this decade, and existing and new international partnerships within the MEP budget
 - An ice-/subsurface-mapping mission augmented for science (iMIM - status unclear)
 - Enhanced coordination with the human program for science and precursor measurements
 - A medium mission in the MEP after sample return, focused on modern climate, habitability, life (point design MLE: Mars Life Explorer)
 - Timely planning for an appropriate Sample Receiving Facility (infrastructure)
 - Continued R&D and technology support (including telecom, landing systems)



Endorsements of Origins, Worlds, and Life (OWL) findings [1 of 3]:

- Analysis of *samples from Mars returned by the end of 2033* will lead to a major advance in our understanding of Mars, its origins, evolution and potential for life.
- *Increased funding for Research and Analysis* is needed, amongst other things, to analyze the volumes of Mars data and eventually the samples being returned from Mars.
- *Technology investment* would enable the next steps in investigating the diverse regions and domains of Mars, evident in the ongoing exploration from orbit and on the surface.
- MEP should “...*develop and execute a comprehensive architecture of missions, partnerships, and technology development to enable continued scientific discovery at Mars.*”
 - *MEPAG believes that such a “comprehensive architecture” should begin with a new program of low-cost missions (<\$300M) this decade (this may be a way to address an aging infrastructure). These should be augmented by medium-class missions after the peak-spending phase of MSR.*
 - *The Mars Concurrent Exploration Science Analysis Group (MCE-SAG) was established to investigate how this might be done, building on the MASWG and other reports.*



Endorsements of Origins, Worlds, and Life (OWL) findings [2 of 3]:

- *Astrobiology and ice science objectives* would have *high value for medium-class missions* (e.g., Mars Life Explorer, MLE).
 - MEPAG had originally advocated that Mars have an entry in the New Frontiers competition, but supports the PSADS recommendation for an MEP mission or missions (competed) that focus on extant life and ice science to launch in the next decade.
 - MEPAG believes that there needs to be further discussion (e.g., a SAG, conferences, etc.) before moving to a SDT/MDT for implementing a medium-class mission and stands ready to support such discussion on this very important topic.
- MEPAG applauds the inclusion of a detailed IDEA section in OWL, enthusiastically supports the work of the IDEA representatives on our Steering Committee and the AG-wide committee they serve on, and *looks forward to implementing recommendations to support a more inclusive, diverse, equitable and accessible Mars science community*. MEPAG recommends continued NASA support of this initiative, and encourages continued engagement and concrete movement.

Endorsements of Origins, Worlds, and Life (OWL) findings [3 of 3]:

- I-MIM: OWL stated “[w]ith engagement of the scientific community in measurement definition, I-MIM has the potential to be a pathfinding example of how Mars human exploration objectives can simultaneously advance high-priority science questions related to Mars climate and how scientific expertise can help successfully realize human exploration objectives for ISRU.”
 - The Measurement Definition Team (MDT) report (just released and to be discussed at the October 26 virtual MEPAG meeting) suggests that the core payload will work for the ISRU objectives and with some augmentation could achieve high-priority ice science objectives. In the meantime, I-MIM disappeared from NASA’s future year budget and the study is being closed out.
 - The international partners are assessing how to proceed.
 - MEPAG is worried that the uncertainty will penalize other mission approaches to achieving the ice science objectives which are high-priority for Mars and have implications for volatiles elsewhere in the solar system.
 - MEPAG believes a deeper discussion of the science possibilities with the participant communities early in the collaboration may have led to a better result and is hopeful that a future opportunity can be defined to satisfy both the exploration and ice science objectives examined by the MDT.

Near-Term MEPAG Activities: Virtual Meetings on October 26-27

- Conduct a “deep dive” panel discussion with PSADS Mars Panel Members
- Discuss the i-MIM MDT report
- Discuss report from the MCE-SAG (final report by end of 2022)
- Update on MSR
 - MEPAG is concerned (see Finding #11 in back-up) regarding how MSR Program requirements (e.g. sample cache deposit) are communicated within the context of otherwise highly constrained Mars 2020 activities. Clear communication between the MSR flight program, M2020, and the Sample Return Project will sustain the goals of both MSR and MEP.
 - A sample caching workshop is being held as we speak

Mars Exploration Program Analysis Group (MEPAG)



Summary of findings from 39th MEPAG, 2-4 May 2022

- MEPAG supports the 10% R&A finding and emphasizes its long-term importance; hopefully CAPS does as well!
- MEPAG supports technology maturation and it would help if CAPS could more cleanly endorse a MEP architecture that incorporates innovative low-cost science flight missions.
- The findings on OWL are interpreted as the need for a medium-class mission that addresses the high science priorities of ice science and extant life. How to do that requires deeper discussion of the science to be achieved.
- The IDEA finding should be endorsed by all, and will enable continued growth of the planetary community.
- There is an urgent need to refresh the current assets at Mars in order to provide future relay and reconnaissance infrastructure.
- All elements of the MSR campaign need to work to provide better (i.e., clear, timely, inclusive) communication across the MSR programs and flight projects.



Backup slides

Mars Exploration Program Analysis Group (MEPAG)



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Sona Hosseini

MEPAG 39th Findings (complete)

Mars Exploration Program Analysis Group (MEPAG)



Preamble

At the May 2-4, 2022 Mars Exploration Program Analysis Group (MEPAG) Meeting #39, the Mars community conducted an initial assessment of the recently released Planetary Science and Astrobiology Decadal Survey committee report, and received a preliminary report from the I-MIM MDT, a review of Mars Sample Return status, and several current mission updates, including the outcome of the 2022 Planetary Mission Senior Review and the initial planning for deploying the first cache by Perseverance. Before presenting findings from the meeting, MEPAG as a community wishes to express the following:

- MEPAG congratulates the Decadal Survey committee for their efforts on behalf of the entire science community, and specifically their clear recommendations for the Mars Exploration Program (MEP) and Mars Sample Return (MSR).
- MEPAG expresses deep sympathy to our colleagues regarding the suspension of the ExoMars rover launch due to the present international situation. MEPAG supports and will continue to follow ESA and the international community in their efforts to recover this very important science.

Mars Exploration Program Analysis Group (MEPAG)



MEPAG Findings Overview

- The Mars Exploration Program Analysis Group (MEPAG) strongly concurs with the Origins, Worlds and Life (OWL) report on the importance of returning samples from Mars to Earth by the end of the decade (2033), on increased funding for R&A to cope with the massive return of data by planetary missions, including those at Mars, and to invest wisely in the technologies that can enable future exploration at Mars and across the Solar System.
- The Planetary Science and Astrobiology Decadal Survey also presented an overarching challenge to NASA and its Mars Exploration Program and thus to MEPAG that MEP should *“...develop and execute a comprehensive architecture of missions, partnerships, and technology development to enable continued scientific discovery at Mars.”*
- *Consistent with OWL’s text and reports from study groups such as MASWG and a KISS workshop, MEPAG believes that such a “comprehensive architecture” should begin with a new program of low-cost missions (<\$300M) this decade, augmented by medium-class missions after the peak-spending phase of MSR.*

These and other findings are discussed in more detail in the following slides.

1. Finding: Decadal Survey initial thoughts 1, MEP

- The Planetary Decadal Survey report *Origins, Worlds and Life* (OWL) has unambiguously recognized the profound strategic and scientific benefits of the comprehensive program structure under which Mars exploration operates (the Mars Exploration Program, MEP). The report recommends the continuation of the MEP “success story,” which strategically plans Mars exploration using the full umbrella of tools within the MEP architecture, from small to medium-class missions, and from infrastructure to development of enabling technology.
- *MEPAG enthusiastically endorses the recommendation that MEP “...develop and execute a comprehensive architecture of missions, partnerships, and technology development to enable continued scientific discovery at Mars.” MEPAG believes that such a “comprehensive architecture” should begin with a new program of low-cost missions (<\$300M) during the execution of the MSR flight program, augmented by medium-class missions after the peak-spending phase of MSR, as noted in OWL.*
- *The funding for this architecture of low-cost and New-Frontiers (medium) class MEP missions would come from restoration of MEP funding as recommended by OWL.*

2. Finding: Decadal Survey initial thoughts 2, MSR

- Mars Sample Return (MSR), with its goal of providing a scientifically return-worthy cache of samples for return to Earth, was noted by the last Decadal Survey as the highest priority for flagship missions in the decade 2012-2022. MSR remains the highest priority robotic exploration goal in OWL, for 2023-2032.
- *MEPAG welcomes the recommendation to finish MSR “as the highest scientific priority of NASA’s robotic exploration efforts this decade” and to do so without undermining “the long-term programmatic balance of the planetary portfolio.”*

3. Finding: Decadal Survey initial thoughts 3, R&A

- The OWL recommendation that PSD “increase its investment in R&A activities to achieve a minimum annual funding level of 10 percent of the PSD total annual budget” is timely and, given the magnitude of returned data from all the planetary missions, sorely needed.
- *MEPAG strongly encourages that NASA adopt the OWL recommendation to bring R&A funding to the 10% level, in line with pre-2018 levels.*

4. Finding: Decadal Survey initial thoughts 4, technology

- The many technology recommendations in OWL are welcomed, particularly as they pertain to the ability to reach the Mars surface in an affordable way and provide access to the subsurface as well. Recent studies have highlighted the benefits of technology that would enable a number of MEPAG goals (e.g., affordable access to the surface; high-volume communication; subsurface access; mobility).
- *MEPAG welcomes opportunity for MEP to use all the strategic tools available to it, to explore Mars, including innovations like low-cost missions and associated support of technology maturation. MEPAG will study the many recommendations in this area with the intent of identifying ways in which its studies could further refine OWL recommendations.*



5. Finding: Decadal Survey initial thoughts 5, MLE

- While MEPAG previously advocated that Mars be included in the New Frontiers competition, it affirms the language used in OWL whereby medium-class missions for Mars exploration are best defined and executed strategically within the MEP, and that MEP funding be restored to levels that would make a new start for the first of such missions possible late in the decade. MEPAG agrees with OWL that astrobiology and ice science objectives would have high value for such medium-class missions (e.g., Mars Life Explorer, MLE).
- *MEPAG stands ready to build on current studies with science analysis groups as needed to define and refine objectives of an astrobiology/ice science Mars mission, which by its placement in MEP further enhances the ability of the program to define compelling precursors and successors in a long-term exploration strategy. Given MEPAG's long-standing emphasis on competing mission scope & implementation, we look forward to community participation in a future SAG, SDT & AO informed by the community.*

6. Finding: Mars exploration concurrent with MSR

- OWL recommended that the Mars Exploration Program (MEP) strategically plan and execute Mars exploration concurrent with MSR. Several highly relevant community-based studies are now available regarding concurrent exploration avenues, including the recommendations of the Decadal Survey report, the updated MEPAG Goals Document, the MASWG report, the KISS Workshop ('Revolutionizing Access to the Mars Surface'), ICE-SAG and Nex-SAG, the Low-Cost Science Mission Concepts for Mars Exploration Workshop, and the I-MIM MDT preliminary report.
- *MEPAG strongly endorses the need for a strategic plan for exploration concurrent with MSR that is science driven. To that end, MEPAG will stand up a Mars Concurrent Exploration (MCE) SAG, tasked with identifying and prioritizing scientific objectives and/or investigations that could be executed within the next ten years, in parallel with the MSR effort and in conjunction with DS guidance for the MEP. This effort is planned to be completed by mid-September, 2022.*

7. Finding: Inclusion, Diversity, Equity, Accessibility

- The “State of the Profession” section in OWL offers many important recommendations for improving Inclusion, Diversity, Equity and Accessibility (IDEA) in the planetary community. MEPAG welcomes the workshop “Advancing IDEA in Planetary Science”, hopefully the first of many, and looks forward to the work of the AG-based IDEA committee.
- *MEPAG applauds the inclusion of a detailed IDEA section in OWL, enthusiastically supports the work of the IDEA representatives on our Steering Committee and the AG-wide committee they serve on, and looks forward to implementing recommendations to support a more inclusive, diverse, equitable and accessible Mars science community. MEPAG recommends continued NASA support of this initiative, and encourages continued engagement and concrete movement.*

8. Finding: Infrastructure

- The assets conducting ongoing orbital science and rover data return are aging but continue to provide crucial science data and communication relays. The need for continued reconnaissance science and systematic monitoring has been identified by a number of studies, and the relay burden will only increase given the arrival of missions to be launched in the next decade. Approaching both orbital science and relay needs by design will maximize resources for the entire program.
- *MEPAG encourages a systematic approach to supporting and refreshing Mars orbital science, monitoring, and relay requirements both in the near-term for upcoming missions, and in the longer term (a move that could dramatically enable highly productive Mars small spacecraft concepts). New architecture and aggressive approaches could leverage new technology to substantially increase bandwidth for Mars which could be enabling for small missions.*

9. Finding: Current missions

- The latest Senior Review provided high ratings for the ongoing Mars missions, and the Decadal Survey report (OWL) noted the exceptional value that such mission extensions are providing. This is particularly true for Mars where mission extension has greatly enhanced the scientific return of landed (e.g., Perseverance, InSight, Curiosity) and orbital (synergies among MAVEN, MRO, TGO, ODY & HOPE) missions. This is an excellent example of the program-level approach recommended by OWL for sustaining Mars exploration (as well as other areas of planetary exploration).
- *MEPAG agrees with the above conclusions and encourages continued support of these missions at levels necessary to maintain high scientific return.*

10. Finding: I-MIM Measurement Definition Team

- While noting the controversial history of its beginnings, OWL states that “[w]ith engagement of the scientific community in measurement definition, I-MIM has the potential to be a pathfinding example of how Mars human exploration objectives can simultaneously advance high-priority science questions related to Mars climate and how scientific expertise can help successfully realize human exploration objectives for ISRU.” MEPAG is grateful for NASA and partners’ efforts toward organizing the I-MIM MDT, commends this committee’s ongoing work, and is intrigued by its preliminary findings regarding the reconnaissance and science goals of the mission concept. MEPAG was surprised by the lack of funding for I-MIM in the FY23 Administration budget (prior to the release of the MDT report), and in light of the OWL endorsement of the importance of a Mars ice mapping-type mission.
- *MEPAG eagerly awaits completion of the final MDT study. This will enable the community to fully evaluate the degree to which the I-MIM mission concept addresses key goals of the Mars community regarding ice investigations, and will place in clearer context OWL discussions regarding I-MIM or a similar type of joint mission as an Agency-level priority.*

11. Finding: MSR in relation to Mars 2020

- MEPAG applauds the ongoing MSR Program mission element studies and engineering tests such as those involving the Mars Ascent Vehicle Integrated System (MAVIS) and Earth Entry System (EES). MEPAG also appreciates the rationale for establishing the MSR Campaign Science Group and the MSR/MEP Joint Steering Group to ensure frequent, high-level discussions among key leadership. However, MEPAG is concerned regarding how MSR Program requirements (such as assessing locations for sample cache depots) are communicated within the context of otherwise highly constrained Mars 2020 mission operational scenarios, and their impacts on maintaining efficient progress toward accomplishing mission science goals.
- *MEPAG underscores the importance of discussion and clear communication at all levels as the Mars 2020 and MSR teams work to achieve a balanced mission operations approach that will sustain the goals of both MSR and MEP in an efficient manner during the entire course of the Mars 2020 mission.*