

Summary of the presentations, discussion, and main outcomes of the 33rd MEPAG meeting **February 22-23, 2017 @ Monrovia, CA**

Posted agenda and presentation files: <http://mepag.nasa.gov/meetings.cfm?expand=m33>

This summary presents an overview of discussion at the meeting as well as presentation materials. *Completed March 16, 2017 and posted to https://mepag.jpl.nasa.gov/meeting/2017-03/Summary_MEPAG33_v5.pdf.*

Key MEPAG Announcements

- *Please send any feedback via the email MEPAGmeetingOs@jpl.nasa.gov.*
- We welcome Don Banfield as the new **Goals Committee Chair**.
 - We thank Vicky Hamilton for her effort as the Goals Committee Chair that resulted in the 2012 and 2015 Goals Document revisions.
 - The full Goals Committee membership is listed at <https://mepag.jpl.nasa.gov/about.cfm>.
 - A first task will be to examine the key Mars Polar Science questions resulting from the [recent Mars Polar Science conference](#), as [presented by Isaac Smith](#) at the meeting.
- The **Mars International Collaboration Science Analysis Group (MIC-SAG) report** was completed and presented to the MEPAG community by Chair Bruce Jakosky.
- We discussed possibly having the **next MEPAG “face to face” meeting** during the week of July 10, 2017. Such a meeting would be finalized once NASA receives additional information regarding future planning that can be disseminated and discussed with the community. More information on this is expected by late March.
- A [proposal](#) was presented for quarterly MEPAG events, with at least one and possibly two meetings to be face-to-face and others to be conducted as virtual events. This suggestion was generally supported and plans for a first virtual panel will be explored in the near future.

MEPAG and Mars science community activities

- Jeff Johnson, MEPAG Chair, [started the meeting](#) with a revisit of MEPAG’s charter, including what MEPAG is, who is involved, and the type of activities undertaken by this group. His presentation also outlined [Planetary Science Subcommittee](#) meeting findings from the September 29-30, 2016 meeting and discussions relevant to Mars: Special Regions, Extended Missions, and R&A Programs.
- Bruce Jakosky, Chair of the Mars International Collaboration Science Analysis Group (MIC-SAG), presented that group’s [final report](#). This report outlines the important processes and systems that need to be in place to facilitate mission success, regardless of how a science team is composed (e.g., PI-led, facility model, observatory). It was recognized that while both benefits and risks/costs come with international collaboration, such joint ventures ultimately are undertaken to strengthen and improve missions. However, proper implementation and adequate funding are key to success. Discussion focused on emphasizing several key recommendations and community concerns (generally reflected in the MIC-SAG report) and on how NASA and MEPAG are engaging international collaboration and potential commercial partnerships. International collaboration with instrument proposals/development can be used to address challenges in the current budget environment, particularly when working within a system that may not yield resources for much more than replenishing the telecommunication infrastructure. But such collaborations can also move

more than one nation's strategic goals forward while gathering a wider range of expertise and experiences. MIC-SAG also took a quick-look at the potential role of commercial partnering, but found that this topic needed much more consideration than was possible by the mandated report time.

- Presentations were invited on recent Mars-relevant conferences:
 - Isaac Smith (Planetary Science Institute) [presented a summary](#) of the [6th International Conference on Mars Polar Science and Exploration](#), and discussed mismatches identified between the MEPAG Goals Document and the key Mars Polar Science questions in both investigation scope and in priority (see *Future MEPAG Activities* for more on this);
 - Sabrina Feldmann (JPL) [presented a summary](#) of the [3rd Workshop on Instruments for Planetary Missions](#) (IPM-3);
 - Lindsay Hays (Mars Program Office/JPL) [presented](#) on the [2016 Biosignatures Workshop](#), and Bethany Ehlmann (Caltech) [presented](#) on the recent [Rock-hosted Life Workshop](#). These two presentations and the subsequent discussion session focused on implications from the workshops on how the search for biosignatures on Mars is planned.
 - For example, we discussed the differences and synergies in collecting samples that confirm biosignatures as opposed to collecting samples that confirm aqueous activity, and which environments could be investigated (e.g., areas where life may have originated but which might not remain habitable indefinitely; areas where erosion has exposed the types of rocks most likely to host biosignatures).
 - The question was also raised about how surface radiation could benefit or retard certain prebiotic chemistries. Lindsay noted that this subject was discussed extensively in the Biosignatures workshop, and is included in the [resultant review paper](#).
 - A key outcome from these workshops and discussions was the concept of “Seek the interfaces”, i.e., explore permeable zones or oxidizing fronts where such regions of disequilibria may drive potential metabolism.
- Three working groups organized broader than MEPAG but involving MEPAG members/interests were also discussed. Amy Kaminski (NASA HQ Chief Scientist office) presented on a [workshop on citizen science](#) opportunities and challenges; Tom Duxbury (George Mason University) presented on a [Phobos/Deimos working group](#); and Alex Pathoff (JPL) presented on the [Mapping and Planetary Spatial Infrastructure Team \(MAPSIT\) group](#), which used to be the Cartography Research Assessment Group (CRAG).

Overviews of Mars Exploration Program (MEP) Accomplishments and Plans

- Jim Watzin (NASA MEP Director) spoke without slides about current MEP activities and plans. These include work with ESA in support of the Schiaparelli landing last September and subsequent anomaly investigation and of the MOMA instrument development on ExoMars. Work and reviews for 2020 are going very well (see below for Project presentations). For plans beyond 2020, Jim explained that, until the ongoing transition activities are completed and budgets are revealed, MEP is unable to move forward with planning for the future, but is trying to be prepared once boundary conditions are set for the Program. For example, an industry study (first mentioned during [MEPAG meeting 32](#)) was completed that determined that industry has the product lines that would be able to meet requirements for a new Mars orbiter, but the scope of such a mission concept and its schedule has not yet been set.

- Fuk Li (JPL) spoke about the work needed to prepare for upcoming EDLs in 2018 (InSight) and 2020 (ExoMars and NASA rovers and SpaceX Red Dragon landers) and other critical events (such as orbit insertion of missions from UAE, India, and possibly China). A key issue is how to coordinate telecommunications support for all [the many missions expected](#) to arrive at Mars around 2021. These presentations briefly touched on the analysis that is ongoing, and focused on determining how to track and prioritize the needs of the many missions.
- Michael Meyer (NASA Lead Mars Scientist) gave an overview of [ongoing science activities within MEP](#), including the recent 2020 Mars Rover Landing Site Workshop, awards in the Mars Data Analysis Program (MDAP), recent big science results, and the high level of public interest in Mars mission information and events. In particular, he pointed out that people enjoy participating as well as following (e.g., citizen science projects, and “send your name to Mars” events), and that even during a year when no large-publicity events occurred (such as an Orbit Insertion) the Mars website is still in the top 5 NASA sites. A short discussion focused on how the community can help to raise public interest higher, even during years when high-profile mission events are not occurring. A question was also raised about the [NAS study on strategic missions](#) and what MEPAG could do to help with that discussion. MEPAG and the Mars Program Office had already provided the study members with publication counts and such information, and are ready to respond to follow-up questions. It was noted that MEPAG is a great resource for developing useful information about the value of those types of missions.
- Each of the five ongoing NASA Mars missions (MSL, MAVEN, MER, MRO, and ODY) successfully passed the Senior Review and was granted an extended mission. As a result, it was appropriate to hear from each mission regarding their current and planned activities. Current missions are progressing well, and producing many great science results:
 - Ashwin Vasavada (JPL) presented on the [Mars Science Laboratory \(MSL\) mission](#);
 - Bruce Jakosky (LASP, University of Colorado, Boulder) presented on the [MAVEN mission](#);
 - Abigail Fraeman (JPL) presented on the [Mars Exploration Rover \(MER\) mission](#);
 - Leslie Tamppari (JPL) presented on the [Mars Reconnaissance Orbiter \(MRO\) mission](#);
 - Jeff Plaut (JPL) presented on the [Mars Odyssey \(ODY\) mission](#);
 - Bruce Banerdt (JPL) presented on the [InSight mission](#) – this mission is on-track for its launch window, which opens May 5, 2018.
- The 2020 Mars rover project is progressing well:
 - Matt Golombek (JPL) presented on the [3rd 2020 Mars rover Landing Site Workshop](#), which had occurred just two weeks prior. The landing site candidates were downselected from eight to three: Jezero Crater, Northeast Syrtis, and Columbia Hills in Gusev Crater.
 - At the MEPAG meeting, there was further discussion by individuals about MEPAG’s role in the landing site selection results and process, which is guided directly by MEP and which reports to the 2020 project and a HQ-chosen Landing Site Steering Committee. MEPAG does not participate directly in this well-established, but endorses the opportunity for all community members to participate.
 - With just three sites now in consideration, the form of the the next Landing Site Workshop may evolve, but it is expected that during late summer 2018 the three sites will be assessed in more detail with respect to science objectives and the 2020 instrument payload, including the ability to detect biosignatures.

- Ken Farley (Caltech) presented on the [Mars 2020 Project Science](#) progress, with regards to the science value that had been discussed at the Landing Site Workshop for the three candidates, development of the 2020 rover's science instruments and sample caching system, work to improve rover operability and efficiency, and the Project's first full science team meeting (planned for June 2017).
- Matt Wallace (JPL) presented on the [overall status of the 2020 Mars rover Project](#), including current spacecraft build progress and plans and the timeline of Project workshops and reviews -- the next being the CDR which would be held the following week. The existence of actual flight hardware (e.g., components of the cruise stage) at this time reflects the MSL design heritage.
- Discussion included a question about expected relay pathways for the 2020 Mars rover, including if MRO was lost before the rover had completed its primary mission – these options are being looked at, although it is recognized that while MAVEN has sufficient data volume, the overflight cadence (with the current/planned MAVEN orbit plan) would be a challenge. The potential helicopter was also inquired about – the 2020 Mars rover Project was asked to initiate accommodation studies for a helicopter, and HQ is now deliberating whether or not to add this demonstration to the mission.
- There was much discussion about the current lack of a defined Mars Exploration Program post-2020 and requests for what the Mars community can do to help with this situation. Jim Watzin said that the Mars science community has done a good job as a community in promoting our needs and explaining what is needed to address those needs – and this feeds into high-level discussions. He explained that what is needed from the community most now is a continued presence and awareness. Ongoing consideration about how to make the program pragmatic and affordable (i.e., drive down both costs and the perception of cost/risk) is necessary, as we are within a cost-constrained environment. It was recommended that MEPAG and MEPAG members should continue to think about potential collaborations, citizen science opportunities, and how to maintain the current public interest level. Additionally, we need to be organized and steadfast in support of the [last Decadal Survey](#) and its recommended progress towards Mars sample return.

International Reports

- Status for the ongoing ESA Mars missions were shared:
 - Håkan Svedhem (ESA) presented on [ExoMars](#):
 - The Trace Gas Orbiter (TGO) had a successful orbit insertion on October 19, 2016 and all science instruments have demonstrated successful operation. Orbit adjustments are ongoing as planned, and the final science orbit is expected to be achieved in March 2018.
 - The Schiaparelli landing and subsequent anomaly investigation (supported by MRO) occurred recently; a report from the internal ESA Project will be released shortly and an independent investigation by ESA Inspector General will be completed by March.
 - The ExoMars 2020 Project review timeline was shown; the Project is proceeding towards a Check Point Review in April-May 2017. Their fourth Landing Site Selection Workshop will occur March 27-28, 2017, when they will recommend the second candidate landing site (choosing between Mawrth Vallis and Aram Dorsum; the selected top candidate is Oxia Planum). A question regarding an expected call for

Participating Scientists with the 2020 ExoMars Rover was answered in the affirmative.

- Dmitriy Titov (ESA) presented on the [Mars Express mission](#) (from slide 24). Spacecraft, operations, and archiving activities are proceeding as planned, and they expect their mission extension to be confirmed in the near-term. Their Science Goals (within 2017-2018 and 2019-2020) were shared.
- In the first detailed description to MEPAG, Project Manager Omran Sharaf (Mohammed Bin Rashid Space Center) presented on the [United Arab Emirates \(UAE\) Hope Mission](#), which will launch in 2020. This mission has three instruments developed with US partners: EMIRS, a fourier transform IR spectrometer (Arizona State University), EMUS, a UV imaging spectrograph (LASP, Univ. of Colorado, Boulder), and EXI, an imager (LASP). The spacecraft will fly an elliptical orbit with periapse at 20,000 km near the equator (~Deimos orbital radius). This mission will contribute to the greater Mars science (i.e., data will be shared with the community) and will advance the UAE in technical knowledge and inspiration for its people. In anticipation of a post-oil economy, science expertise needs to be established to expand their existing engineering expertise and to provide career paths for their youth. This is a start – the UAE recently announced a program called “Mars 2117” with an aim to send a strong message that there is a larger and continued plan for investment and progress for the next 100 years.
- Victoria Hipkin (CSA) presented for the [Canadian Space Agency \(CSA\)](#). For Mars, one work of particular interest is an investigation of Mars Sample Return Analogue Deployment which had a field exercise with the rover prototype in the Utah Desert in fall 2016. CSA also held a Workshop November 22-23, 2016 to identify the space science objectives and investigations Canada should pursue mid-2020s through 2040; a final report is planned to be released in May 2017.

Human and Commercial Exploration

- The status of NASA plans were presented:
 - Ben Bussey (HEOMD Chief Exploration Scientist) presented an [HEOMD Overview](#), including the Mars Architecture studies, the HEOMD-involved 2020 Mars rover instruments, Phobos and Deimos Strategic Knowledge Gaps (SKGs), and ongoing/future projects planned within NASA’s ISRU activities.
 - Ben Bussey and Rick Davis (NASA SMD) presented an [update on the Human Landing Sites Study \(HLS²\)](#). Since the First Landing Site Workshop (October 2015), ~55% of the approved MRO data requests have been completed; the next Landing Site Workshop is anticipated to be in Fall 2017. A workshop was held at the Fall 2016 AGU Meeting to identify new “user” data products (produced from existing data sets) that could be used to identify sites or regions with high potential for productive water deposits.
 - Discussion focused on HEOMD plans and activities spanned a range of topics:
 - A question was asked about the figure of merit for allowing people to go to Mars and go outside – The current plan would be to send a crew of four people, but their expected number of EVAs is not yet defined. The issues with keeping the dust out and such are really tricky and not yet solved. However, it is recognized that if a trained science explorer is on the martian surface and that person can go outside, they’d accomplish specific science goals much faster than robots.

- The extent to which HEO is interested in supporting or leading efforts to acquire measurements with e.g., a future Mars orbiter for exploring water availability was also inquired about – at present, HEO is not part of any potential future orbiter studies as such data are not regarded as needed now (i.e., those water deposits are not in the critical path). However, this may change as the architecture design changes and expectations with regards to how to use water are altered.
 - A question was asked about if the EDL “tall pole” for human Mars surface missions could be retired with something less than a (robotic) mission at full human-mission scale -- While there are aspects that can be taken retired with a sub-scale mission (e.g., with same ballistic coefficient), for the full sequence of events we may need to start using the landing system that would be used by the human side within a future robotic mission, and this would require HEO and SMD working together. Then cargo missions, potentially preceding humans, could further test the system with larger masses. Additionally, over the next decade(s), there may be multiple providers testing and retiring capabilities.
 - The plans for re-evaluating and filling SKGs were inquired about – MEPAG Goal IV investigations were last revisited in [2015](#), and fully evaluated in [2012](#) (based on the [P-SAG report](#)); since then, the Humans to Mars Architecture has not been refined further. As has been done in the past, evaluation and definition of SKGs will be completed with the science community.
- Additionally, Harley Thorson (NASA GSFC) presented on the [AM workshop series](#) (most recently AM-IV – AM initially stood for Affordable Mars and has now evolved into Achieving Mars). Each workshop is a gathering of scientists and engineers, with meeting organization by Explore Mars, Inc. One of the main findings from this group has been that while science alone does not have “broad enough shoulders” to justify sending humans to Mars, sending any humans within a Mars exploration campaign would require a compelling major science scenario. From their studies, they think that human orbital missions could be done as early as 2026/2028, with no major technical or engineering issues preventing humans from getting to Mars in the early to mid-2030s.
- Scott Hubbard (Stanford University) presented a concise [overview of Commercial Space](#). Ben Clark (Space Science Institute, formerly Lockheed-Martin) and Paul Wooster (SpaceX) also answered questions within the following discussion.
 - The aim of this presentation was to provide a common understanding within MEPAG about e.g., what is “commercial space” (space goods, services, or activities provided by private sector enterprises that have customers beyond the US government and with costs paid through more than government funds). Many players have been and are developing technologies and business plans (e.g., SpaceX and Orbital Sciences are delivering cargo to the ISS, and the Sierra Nevada Dreamchaser was recently also selected), but all of the active missions have so far been within the Earth vicinity. For deep space, work is ongoing to develop technologies related to, e.g., space mining, competitors to the Google Lunar XPrize, and missions to Mars.
 - Discussion on this topic included the following points:
 - There’s a strong interest within the MEPAG community to identify ways to partner with commercial space entities who can perhaps provide a different type of access to the Mars system; the costs and other needs of such a partnership need to be identified. Additionally, based on the [MIC-SAG report](#) – it was recognized it would be best to

get people involved in design early, for such a partnership. Further discussion in this direction is recognized as a timely MEPAG topic (see *Future MEPAG Activities*).

- Since the planned first SpaceX Red Dragon launch date has been moved from 2018 to 2020, this presents a greater chance for discussion with the community. Current comments from SpaceX – they can provide payload volume within the interior of the Red Dragon capsule (which has a large volume), or on the parachute module (which will be closer to the surface), or released from the spacecraft along the trajectory. There have been some studies for different instruments and deployment methods, but nothing more is yet set.
- It is important to remember that commercial space companies are for-profit entities. This has several implications, one of which is that if there is more than one provider then the price *tends* to go down. Another important open question is how much such sending a payload will cost (in \$/mass transported, in accommodation development and build, etc.).

Future MEPAG Activities

- **V2050:** Jeff Johnson presented a draft version of his presentation for the NASA Planetary Science Vision 2050 (V2050) Workshop and received useful feedback regarding how to increase the background rationale for Mars exploration as engendered by the Decadal Survey. The final version of his presentation is available on the [V2050 webpage](#).
- **Goals Document:** Isaac Smith will be invited to speak with the MEPAG Goals Committee (Don Banfield, Chair) about the Mars Polar Science key questions, and determine where gaps exist within both investigations and priorities with the current (2015) MEPAG Goals Document. Options for revision will be identified by the MEPAG Goals and Executive Committees and will be presented to the MEPAG community for comment and decision.
 - It was also noted that a MEPAG science goal does not lead into a mission; instead missions typically are cross-cutting through multiple goals. (In the last Decadal Survey, a Mars Polar Science mission was a New Frontiers candidate; this should be reconsidered, as well as smaller mission possibilities, in preparation for the next Decadal Survey.)
 - A question was also asked about a revisit to Goal IV content – this is postponed until an ongoing HEOMD architecture study has been completed.
- **Decadal:** The [mid-term Decadal Survey study](#) has a committee and will begin meeting in May. A report is expected in March 2018.
 - Within preparation for the next Decadal Survey (~2023-2032), it was asked: what is the role of MEPAG? MEPAG can analyze an architecture (or components of an architecture), as was done for the last Decadal Survey, but that architecture was provided by MEP. Currently, there is no committed architecture for MEP into the next Decadal's timeframe. MEPAG is well positioned to come up with the science rationales and priorities, and perhaps could identify what an architecture could look like by helping to prioritize mission concepts (that could achieve e.g., polar science objectives) for more detailed technical study and costing by Mars Program Office (MPO) and MEP in preparation for the next Decadal Survey.
- **Future community discussions and/or SAGs**
 - Note that MEPAG is chartered as an analysis group, addressing questions given to us by our shareholders. Thus, if a topic seems to warrant analysis, it typically is best if it is discussed with Michael Meyer, who would then issue a request. It should also be noted that a MEPAG study is not the only way to acquire necessary information. For example,

the [2016 Biosignatures workshop](#) was organized by MPO and was not a MEPAG activity. (Further study and discussion of biosignatures was also discussed at this MEPAG meeting, and deemed better to work through a future workshop rather than a MEPAG study. Additionally, a session at the upcoming [AbSciCon](#) will discuss this.)

- A re-evaluation of the [Special Regions report](#) had been suggested during the early portion of the meeting, but it did not seem that there was enough new information at this time to re-evaluate. Furthermore, in the near-term, a joint Planetary Science Subcommittee (or its successor Planetary Science Advisory Group) and Planetary Protection Subcommittee study is expected.
- Exploration of how commercial opportunities may provide payload options was of interest and was also recommended [by MIC-SAG](#), and may be explored in a future MEPAG event (see *Proposal*, below).
- Small satellite opportunities, near-term mission concepts (such as those feeding into the next Decadal Survey), commercial science opportunities and challenges, and updates to Goal IV were also briefly discussed. However, further prioritization and planning need to wait for NASA direction.
- We discussed possibly having the next MEPAG “face to face” meeting during the week of July 10, 2017. Such a meeting would be planned only after NASA has more direction determined (starting with the administrator being named) and there are sufficient items for community information and discussion. More information on this is expected by late March.
- Serina Diniega pitched a [proposal for quarterly MEPAG events](#). This proposal received general support for an attempt to improve interactions with the community and sharing of information, so long as the added events are virtual and do not add a significant time commitment to the Mars community members. The Mars Program Office and MEPAG Executive Committee will develop a first event and further plans.

MEPAG Summary Comments

- **Mars Sample Return:** MEPAG is pleased with the progress made by the 2020 Mars Rover project in development. However, MEPAG hopes that the other steps required for sample return from Mars (the Decadal Survey’s highest flagship priority) are included formally in NASA planning soon.
- **Mars 2020 mission:**
 - Multiple international launches and landings in 2020 promise a “logjam” in Deep Space Network (DSN) and Mars orbital coverage of landings on Mars. MEPAG requests updates at a future meeting regarding plans for coordination and prioritization of communications with multiple assets, particularly in regard to mitigation plans for off-nominal spacecraft events around this time period.
 - MEPAG remains concerned regarding the challenges associated with communications support required for the 2020 Mars rover to be efficient during its landed mission operations.
- **InSight:** MEPAG is encouraged by the progress that the project has made in solving the SEIS issues in preparation for launch of the InSight spacecraft in 2018.
- **MIC-SAG:** MEPAG thanks the MIC-SAG for their efficient and comprehensive review and analysis of issues related to international collaborations on future missions. By discussing the ramifications of multiple options for such collaborations, the MIC-SAG identified key areas in need of vigilance during mission development and topics that will require additional

consideration in the near-future (e.g., commercial opportunities). Based on the discussion at the meeting, the report is accepted.

- **MEPAG Meetings:**

- At the end of March, MEPAG will assess whether to proceed with a mid-summer (possible week of July 10—TBC) face-to-face meeting to discuss MEP future plans assuming needed information is available at the time.
- MEPAG Executive Committee will consider possible topics for a springtime virtual event.