

Summary of the presentations, discussion, and main outcomes of the 38th MEPAG Meeting
April 15th-17th, 2020
Held virtually via Adobe Connect

These notes are intended to capture highlights of the presentations and key points of the ensuing discussions. It was a packed agenda, touching on major topics. These included:

- 1. Headquarters' overviews of the planetary program and the status of Mars Exploration;*
- 2. An in-depth look at the architecture of the next steps in the Mars Sample Return campaign;*
- 3. An amazing overview of concepts and visions taking shape in numerous Decadal Survey white papers and pre-decadal studies;*
- 4. The status of various Mars missions in development and operations; and*
- 5. A lively discussion of what it all means.*

Details of the presented material and associated discussions (i.e., posted agenda, presentation files, and recordings of the meeting) can be viewed at:

<https://mepag.jpl.nasa.gov/meetings.cfm?expand=m38>.

Thanks to all the presenters and participants (often as many as 250) for their patience in working within the virtual meeting constraints. A special call-out to the Adobe Connect and Mars Program Office staff for their good-natured and steady resolve to make it work--which they successfully did!

Looking forward to our next meeting as a community.

*R. Aileen Yingst
MEPAG Chair*

General MEPAG Announcements

- Please respond to all requests for general or meeting-specific MEPAG feedback via the email MEPAGmeetingQs@jpl.nasa.gov.
- Current plans are to have the next virtual MEPAG meeting (VM9) in late summer or fall, 2020.
- There is a Google Sheets [form](#) for authors to submit info about their Decadal Survey white papers/topics, including links to drafts of the paper and to related sign-up sheets, which will automatically populate this [sheet](#), which also includes links to the LPI site for white papers and other pertinent resources.
- The statement of task and other information related to the 2023-2032 Decadal Survey can be found [here](#). The deadline for white paper submission is July 4th, 2020.

Day 1 – Wednesday, April 15th

MEPAG #38: Setting the Stage

[Welcome, Meeting Preview, MEPAG Updates](#)

MEPAG Chair R. Aileen Yingst [presented](#) an overview of MEPAG, recent MEPAG activities, and the goals and agenda for this meeting. Recording of the presentation is posted [here](#).

- A key accomplishment since the last MEPAG meeting was the completion of the revision of the MEPAG Goals Document. The final version is now available [here](#).
- Aileen gave a MEPAG report to the Planetary Advisory Council (PAC) in March, 2020 which addressed MEPAG activities, FY21 budget concerns, and most recent MEPAG findings. This presentation and other PAC meeting documents can be viewed [here](#).
- A key priority of the MEPAG 38 meeting was to update previous findings and to formulate new ones based on the presentations and discussion.

NASA Planetary Science Division (PSD) Report

NASA PSD Director Lori Glaze gave a [status report](#) on NASA's PSD including the response to COVID-19, the President's FY21 budget request, mission updates, recent and upcoming opportunities for future mission studies, and the preparations and notional timeline for the 2023 Decadal Survey. Recording of the presentation is posted [here](#).

- Impacts due to the COVID-19 pandemic are extensive. The top priority is everyone's safety and protecting hardware and integrity of data for operating missions. Impacts to solicitations and evaluations are expected. The Agency's top mission priorities during the pandemic are to launch *Perseverance* on time and to continue work on the James Webb Telescope, while keeping everyone safe. Teleworking is now standard practice; e.g., review panels are working virtually, so work is getting done.
- Agency updates on this situation can be found at:
 - Web: **nasa.gov** and **nasapeople.nasa.gov/coronavirus**
 - Twitter: **@NASA** and **@JimBridenstine**
- FY21 Budget highlights:
 - One of the largest budget requests in NASA's history, investing more than \$25 billion for America's future in space. This represents an increase of ~12% over last year.
 - Keeps agency on track to land the first woman and next man on the moon by 2024, and helps prepare for future human exploration of Mars with the support of Gateway.
 - Supports priorities from the last Decadal Survey including Mars Sample Return and Europa Clipper.
 - In regards to the deep cuts proposed for ongoing Mars missions, Lori stated that this is an ongoing discussion. Although the total budget is a good number, the constraints and restrictions make it a challenging situation to support all of the different desired and required activities. There are limited ways in which things can be moved around to try to work within the budget. Congressional support has been helpful in the past.
- Mission Updates and Opportunities
 - Mars 2020/Perseverance is on schedule for launch (launch window opens on July 17th, 2020).
 - Three SIMPLEx missions have been selected for Phase A/B development. Release of next opportunity September, 2020.
 - New Frontiers NF#5 planned to be released in Fall of 2022. Committee on Astrobiology and Planetary Science to assess NF candidate list.
 - Four 2019 Discovery proposals were selected in February, 2020 for Phase A. Final selections are planned for April 2021.

- Decadal Survey
 - Information on the Decadal Survey can be found [here](#).
 - LPI and AG websites are open for community collaboration. The LPI repository for White Paper proposals is located at https://www.lpi.usra.edu/decadal_whitepaper_proposals/index.cfm
 - White papers are due on July 4th, 2020

Mars Exploration Program (MEP) Overview

NASA MEP Director Jim Watzin and MEP Chief Scientist Michael Meyer [presented](#) an overview of the current status of the Mars Exploration Program. The presentation included Mars 2020 status, highlights and upcoming milestones, MEP budget status, new MEP mission initiatives, science programmatic announcements, and recent mission highlights. Recording of the presentation is posted [here](#).

- MEP is making major progress and has transitioned to a mostly virtual workspace. The adjustments are being made as smoothly as possible, given the pandemic's uncertain course.
- The FY20 PSD/MEP budget was significantly over-stressed supporting problem resolution in multiple areas on M2020, requiring austerity measures across the entire Mars portfolio with the exception of R&A. M2020 cost has stabilized and the mission is on track for July 17th, 2020 Launch Readiness Date (LRD).
- FY21 President's Budget Request overall is favorable for MEP, but available funding for continued extended mission longevity is limited.
 - Mars Odyssey at risk of close-out in FY21. During follow-on discussion about this Jim Watzin said that discussion and planning is ongoing to forestall and preserve option space for if the funding allocation for ODY is increased. They are trying to preserve the mission for as long as possible. Also stated that if ODY is retired that NASA feels able to proceed with the three NASA orbiters and ESA's TGO providing communications and relay support
 - MSL operations reduced in FY21.
 - A major increase in the Future Missions budget line supports work on the next flight elements in Mars Sample Return and also supports a new, internationally leveraged Mars Ice Mapper mission concept, not previously discussed with MEPAG.
 - “The Budget also funds the robotic exploration of Mars, in cooperation with international partners, as a precursor to human exploration. In addition to performing cutting-edge scientific investigations, a new Mars Ice Mapper mission would provide data for potential landing sites, and a Mars Sample Return mission would demonstrate the ability to launch from Mars' surface.”
 - MSR has a 6-year development cycle with a 2026 LRD (2031 return).
 - Mars Exploration Ice Mapper is meant to search for accessible resources for In-Situ Resource Utilization (ISRU) by missions bringing humans to Mars. A possible collaboration with the Canadian Space Agency (CSA) which would provide an L-band synthetic aperture radar to search for shallow ice was described. Possible application to science objectives was

noted. This Exploration Initiative envisions a 5-year development cycle (2026 launch).

- More information about both of these initiatives was presented in the next session.
- Michael Meyer discussed the two main science planning activities currently underway for MEP and gave an overview of the science program, including some recent science highlights from MRO, MSL, and MAVEN.
 - MDAP: 21 of 101 proposals selected and were announced March 31, 2020
 - A solicitation for MSL Participating Scientists has been postponed due to reduced budget in FY21, and lack of budget in FY22.
 - MOMA Participating Scientist call has been postponed due to ExoMars launch delay.

Mars Exploration Program: Going Forward

This session featured five presentations related to the current state of planning for the MSR Campaign, including Planetary Protection (PP) considerations, and one joint presentation about the Mars Exploration Ice Mapper mission initiative.

MSR Campaign: Introduction

MEP Director Jim Watzin [presented](#) an introduction to the MSR Campaign including a summary of the current state of planning, proposed campaign architecture, upcoming milestones, and the collaboration between ESA and various NASA centers. Recording of the presentation is posted [here](#).

- Substantial effort was expended in FY16-19 developing the planning and approach for MSR, including establishing the partnership between NASA & ESA, developing a pragmatic, executable architecture, with a disciplined approach to adhere to budgetary guidance. This will be done by focusing the Campaign on its prime mission of returning carefully selected and contained samples to Earth for detailed study.
- There has been a commitment to the principle that sample access will be open internationally. Assessment and analysis of samples will be managed via international governance.
- MSR is transitioning from study to implementation, aiming for a late FY26 launch and samples to be returned to Earth in 2031; the next flight elements in the campaign will enter Phase A in late FY20.
- MSR consists of four main mission phases; 1) The M2020 rover will launch to Mars in July this year and collect the samples, which it will deposit on the surface and/or retain some samples for delivery directly to the Sample Retrieval Lander (SRL); 2) The SRL will deploy a Sample Fetch Rover (SFR) to retrieve deposited samples. After encapsulating the samples into an Orbiting Sample container (OS), the SRL becomes a launch platform for the Mars Ascent Vehicle, which carries the OS into a stable low-Mars orbit; 3) The Earth Return Orbiter (ERO) with its Capture, Containment, and Rendezvous System (CCRS) will capture the OS and encapsulate it in such a way as to satisfy back planetary protection requirements. As it nears Earth, the ERO releases the Earth Entry System which lands the samples safely on Earth (without a parachute). 4) Finally, in 2031, the samples are taken to a containment facility and prepared for detailed analysis.

MSR Campaign: Retrieving the Samples

Austin Nicholas [presented](#) the MSR Timeline and Concept of Operations. This included the full Campaign timeline with a focus on surface operations. SRL surface activities are expected to last ~13 months in order to fit between Ls=0 and Ls=180, when it is northern spring and summer at the Jezero-Midway region. A key advantage of the current planning is the detailed knowledge of the site and its environs. It is also important to avoid the season of large dust storms, as both the SRL and SFR are solar-powered. While M2020 has 43 tubes (including some designed to hold witness plate material, the OS is currently being designed with a storage capacity of ~30 samples tubes. Recording of the presentation is posted [here](#).

MSR: Breaking the Chain of Contact

Morgan Hendry gave a [presentation](#) on breaking the chain of contact and on the means of assuring containment of the OS, including Mars dust on its exterior, as a part of the MSR Campaign strategy for back planetary protection. The MSR Campaign is actively designing systems, verification approaches, and operational strategies consistent with Break the Chain (BTC) and Containment Assurance (CA) objectives. The National Environmental Policy Act (NEPA) process will be initiated with inter-agency procedures and all appropriate stakeholders. Recording of the presentation is posted [here](#).

Expectations for Backward Planetary Protection During Mars Sample Return

Lisa Pratt, the NASA Planetary Protection Officer, gave a [presentation](#) about backward planetary protection strategies and planning, including the work of the Sterilization Working Group and the COSPAR Sample Safety Assessment Protocol Working Group. Dr. Pratt also described ongoing work to update NASA PP policy and future plans for an advisory board on sterilization and molecular deactivation for MSR. In these activities, NASA is drawing upon expertise inside and outside the agency, including experts at universities, commercial entities, and other government agencies. The Mars samples are expected to be treated as hazardous until proven otherwise; if that can't be proven, they will be sterilized before release from containment. Recording of the presentation is posted [here](#).

Conducting Science on the Returned Samples

Michael Meyer, the NASA MEP Chief Scientist, gave a [presentation](#) about MSR Science Planning. The presentation addressed recent and upcoming planning committees focused on maximizing the science that will come from the Mars samples. A new MSR Science Planning Group (MSPG-2) is being assembled to outline the next steps. All of the science planning is being done on an international basis with collaboration between ESA and NASA. Recording of the presentation is posted [here](#).

Mars Exploration Ice Mapper

MEP Director Jim Watzin and Canadian Space Agency (CSA) Radar Ice Mapper Study Lead Tim Haltigin gave a [presentation](#) about a new mission initiative – Mars Exploration Ice Mapper. The President's FY21 budget request included this new initiative with the stated purpose of preparing for human exploration of Mars by determining the location and extent of ground ice on Mars that could be used a resource and constraining the geotechnical properties of potential human landing sites. Recording of the presentation is posted [here](#).

- This Moon-to-Mars initiative is conceived to be a highly leveraged international endeavor, and MEP has been requested to manage the study and implementation.
- As described by T. Haltigin, CSA could provide a L-band synthetic aperture radar (SAR). See presentation for more technical details of the current design.
- Negotiations with other potential international and commercial partners are still in progress, and the concept has not yet been assigned as a project to any NASA center.
- While there could also be potential science goals, they are still notional.
- This mission stirred considerable [discussion](#); see [MEPAG Finding #3](#).

Day 2 – Thursday, April 16th

Preparations for the Decadal Survey

This session focused on MEPAG preparations for the upcoming Decadal Survey on Planetary Science and Astrobiology. Presentations included overviews of MEPAG support for the Decadal Survey (DS), the current status of the DS process, and the completion of the MEPAG Goals Document Update. The 2nd part of the session was comprised of 34 lightning talks focused on white paper topics submitted by the MEPAG community and 3 more extended presentations about the Mars-relevant NASA-funded Planetary Mission Concept Studies (PMCS).

MEPAG Support for Decadal Survey

MEPAG Chair R. Aileen Yingst [presented](#) on the topic of MEPAG support for the DS, which includes providing a forum for white paper topics at this meeting to allow for community discussion, collaboration, and strategizing. Recording of the presentation is posted [here](#).

- There is a googledocs [form](#) for authors to inform others about Decadal Survey white paper topics of interest, which also points to the LPI site for white papers and other pertinent resources.
- MEPAG Steering Committee plans to author white papers covering the MEPAG Goals update, and papers that address findings of the community (e.g., consensus on whether there should be a list of candidate missions for New Frontiers)
- MEPAG Steering Committee plans to sponsor or endorse white papers on crucial topics (Mars as a Compelling Target; Looking for Life Strategy for Mars; Mars Sample Return; Emerging Capabilities; SAG summaries). These will also allow the community to reference them in their own white papers. The MEPAG Steering Committee's purpose is to ensure that key white papers are written through persuasion, by endorsement or by authorship. The community is encouraged to write their own papers, including some regarded by MEPAG as key, but MEPAG notes that fewer well-written papers endorsed by more members of the community will likely be more successful in guiding the Decadal Survey panels and committee to a good result.

Decadal Survey Status

David H. Smith, the Study Director for the Decadal Survey on Planetary Science and Astrobiology 2023-2032, gave a status [report](#). Recording of the presentation is posted [here](#).

- The statement of task and other information about the DS can be found [here](#).
- Deadline for white paper submission is July 4th, 2020

- The [presentation](#) includes Mars relevant language in the statement of task, white paper specifications, and a calendar of early-career opportunities at NASEM.

MEPAG Goals Document Update

Don Banfield, MEPAG Goals Committee Chair, [presented](#) on the MEPAG Goals Document “Mars Science Goals, Objectives, Investigations and Priorities: 2020 Version.” The presentation included an overview of the Goals Document and an explanation of the changes between the 2020 version and the previous various. The committee responded to comments from the community and entertained suggestions received during a review period, and feedback from two earlier virtual meetings. The latest version of the Goals Document is available [here](#). Recording of the presentation is posted [here](#).

White Paper Topics: Overview

Serina Diniega of the Mars Program Office [presented](#) an overview of the subsequent session on white paper topics and Planetary Mission Concept Study (PCMS) talks. 34 white paper topics were presented at the meeting by means of 2 minute/1 slide lightning talks. These were divided into 3 sub-sessions and the slides can be viewed by clicking the topics below:

- [Astrobiology and Subsurface Investigation White Paper Topics](#) (11 total)
- [Mars Atmospheric and Surface Processes // Climate Record White Paper Topics](#) (12 total)
- [Human Resources // New Technologies and Mission Types](#) (11 total)
- Each of these white paper topics was accompanied by a posted 1-2 page description with more detail and contact information. These files can be viewed at <https://mepag.jpl.nasa.gov/meetings.cfm?expand=m38>
- In addition to the white paper topics, 3 PCMS talks were also given:
 - Rob Lillis [presented](#) on the Mars Orbiters for Surface-Atmosphere-Ionosphere Connections (MOSAIC) study.
 - Wendy Calvin [presented](#) on the Mars Orbiter for Resources, Ices and Environments (MORIE) study.
 - Barbara Cohen [presented](#) on the Geochronology for the Next Decade study.

This session was much appreciated and there was considerable discussion in the chat box during the presentations. There is a wealth of material on the MEPAG website and opportunities to join and contribute to the white paper formulation.

Recordings of the session are available as follows:

- [Astrobiology and Subsurface Investigation White Paper Topics](#)
- [MOSAIC PMCS, Mars Atmospheric and Surface Processes // Climate Record White Paper Topics, MORIE PMCS](#)
- [Human Resources // New Technologies and Mission Types, In Situ Geochronology PMCS](#)
- [Discussion](#)

Day 3 – Friday, April 17th

Reports from Mars Missions

This session was primarily focused on reports from Mars missions currently exploring Mars or in development.

Introduction

MEPAG Chair R. Aileen Yingst [presented](#) an introduction to Day 3 activities. Recording of the presentation is posted [here](#).

- Goals for day 3:
 - Present and discuss mission updates and MASWG update
 - Finalize draft findings for MEPAG 38 meeting.
- Updates from Day 2:
 - Addressing DS statement of task re: humans to Mars. Many white papers pointed to “humans to Mars.” This is an important issue and community members should address it as their white paper topics demand, but note that because white papers should be focused on the science, the Steering Committee suggests that the MEPAG Goals white paper (Goal IV) may be pointed to as needed, to allow more text space for science.
- White papers MEPAG Steering Committee intends to author:
 - MEPAG Goals Document (POC Dan Banfield)
 - Mars as a compelling target for science and exploration (POC R. A. Yingst)
 - Mars community consensus regarding New Frontiers candidate list
 - MASWG may also address some of these items in their report.
- White papers that MEPAG encourages to be written:
 - Looking for Life – strategy for Mars (POC Alfonso Davila)
 - Why we need to complete MSR (POC Dave Beaty)
 - MSR science/curation-related activities that need to happen in the 2020s (POC Beaty/McCubbin)
 - Mars beyond MSR (MASWG)
 - Mars as a target for emerging capabilities (POC Scott Hubbard/Chad Edwards)
- Summary of MEPAG 37 Findings (full text can be viewed [here](#))
 - Progress on Mars Sample Return (MSR) is encouraging...
 - ...as is progress (through MASWG) on defining a structure for crucial Mars science in parallel with and post-MSR.
 - MEPAG continues to see possibilities in small spacecraft missions, secondary payloads, and partnerships with international or commercial sector entities.
 - To support both orbital and landed science, MEPAG recommends a systematic approach to relay satellites.
 - MEPAG celebrates the many new international Mars missions!

ExoMars: TGO & 2022 Rover/Surface Platform

ExoMars Project Scientist Jorge Vago [reported](#) on the status of the ExoMars Trace Gas Orbiter (TGO) and on the progress of the ExoMars Rover and Surface Platforms, now scheduled for launch in 2022. Recording of the presentation is posted [here](#).

- TGO spacecraft is healthy; all instruments are working well, with the exception of the ACS TIRVIM channel, whose cryocooler can no longer bring the IR detector to working temperature. After a short hiatus due to pandemic concerns on operations staff, normal operations started again on 11 Apr 2020.
- Due to the inability to work some technical/software issues during the pandemic, the launch of the ExoMars Rover and Surface Platform had to be delayed until 2022.
 - The project is in the process of evaluating what items of the flight ready hardware need to be maintained, replaced, or repaired to accommodate the new launch date.
 - Updated trajectories and the resulting modification of the landing ellipses are being evaluated.
 - The parachute deployment structure was also reviewed. Parachute deployment testing by ESA at JPL allowed for the improvement of the parachute bag design. Final parachute testing using a stratospheric balloon has been delayed due to COVID-19 related travel restrictions but is expected to take place in the fall when stratospheric winds are right.
 - The delayed launch is not expected to impact the ESA-NASA MSR collaboration.

United Arab Emirates Mission to Mars

Omran Sharaf (Project Manager) and Sarah Amiri (Project Scientist) presented a science overview of the Emirates Hope Mars Mission (EMM). Recording of the presentation is posted [here](#).

- The EMM is due to launch in July 2020 and commence science operations at Mars in mid-2021.
- EMM mission is focused on atmospheric dynamics. It will explore the atmosphere of Mars globally while sampling both diurnal and seasonal timescales from a highly elliptical orbit whose periapsis is nearly areostationary.
- Three main science objectives:
 - Characterize the state of the Martian lower atmosphere on global scales and its geographic, diurnal and seasonal variability
 - Correlate rates of thermal and photochemical atmospheric escape with conditions in the collisional Martian atmosphere
 - Characterize the spatial structure and variability of key constituents in the Martian exosphere
- EMM Instruments (all funded by UAE):
 - EMIRS – Fourier Transform IR Spectrometer
 - EMUS – Ultra Violet Imaging Spectrometer
 - EXI – Imager with 12 MP camera with 6 bandpass filters (VIS/UV)

Mars Moons Exploration (MMX)

Tomohiro Usui (JAXA) [presented](#) an overview of the Martian Moons Exploration mission (MMX) on behalf of the MMX project team. Recording of the presentation is posted [here](#).

- The MMX mission is now in Phase B and confirmed for launch in 2024. Its key objectives are to conduct remote sensing of Mars' moons Phobos and Deimos, and to conduct *in situ* observations on Phobos while retrieving samples from the surface for

Earth return in 2029. This would represent the 1st sample return mission from the martian system, and the 3rd Japanese sample return mission.

- The main science goals of the MMX mission are:
 - Reveal the origin of the martian moons
 - Observe processes that have impacted the evolution of the Mars system
- Nominal Science Payload:
 - OROCHI – Wide-angle multiband camera
 - TENGOO – Telescopic camera
 - MEGANE – Gamma-ray neutron spectrometer (provided by NASA)
 - MIRS – Near-infrared spectrometer (provided by CNES)
 - LIDAR – Light detection and ranging
 - CMDM – Circum-martian dust monitor
 - MSA – Mass spectrum analyzer
 - Rover payload – Raman, radiometer, cameras (provided by CNES/DLR)

M2020 (*Perseverance*): 90 Days to Launch

Mars 2020 *Perseverance* Project Scientist Ken Farley [presented](#) the current status of the mission including progress towards launch readiness, contamination control update, and report on science team training and development of the strategic science mission plan. Recording of the presentation is posted [here](#).

- The vehicle shipped in early February from JPL to KSC.
- All hardware including science instruments, technology payloads, and the sampling systems elements have completed rework, retest, re-installation and regression testing on the flight vehicle, with the exception of the final sample intimate hardware which is deliberately slated to be installed in mid-May to minimize any contaminations threats.
- Project remains on track for July 2020 launch period.
- Contamination control update:
 - On track to meet inorganic cleanliness requirements with known and accepted exceptions;
 - On track to meet biological sterility requirement;
 - On track to meet the 1 ppb Tier 1 organic requirements and well within the threshold total organic contamination requirement of 40 ppb.
- 10 Returned Sample Science Participating Scientists have been added to the science team. Selections are in progress for “regular” Participating Scientists and European Returned Sample Science PS’s. All PS’s expected to be on board by mid-summer 2020.
- *Space Science Reviews* special issue on Mars 2020 expected to be completed by landing day (February 18th, 2021)
- Additional points that came up in the Q&A and Discussion:
 - The helicopter will be carried inside a shield during landing to protect from rock strikes;
 - With respect to dust collection, some dust will be captured via accumulation on surfaces (e.g., outside of the sample tubes, inside the OS sample container), and hopefully there will be places with significant dust accumulation which would allow for sampling with the regolith drill bit.

InSight Mission Status and Results

InSight Principal Investigator W. Bruce Banerdt [presented](#) on the current status and recent results of the *InSight* mission. Recording of the presentation is posted [here](#).

- All instruments are operating 24.6/7, as well or better than designed, with the exception of the HP³ mole. The mole is mechanically sound but unexpected soil conditions have thus far prevented it from reaching its planned depth; efforts for insertion continue.
- As expected, *InSight* has found fewer and smaller quakes on Mars than on Earth, but more than on the Moon.
- There are currently 470 events in the *InSight* catalog:
 - 2 Quality A» Clear seismic phases (e.g. P and S) and polarization
 - 90 Quality B» Signal clearly observed, clear seismic phases, but no polarization
 - 176 Quality C» Signal clearly observed, but no clear phases
 - 202 Quality D» Signal only weakly observed » OR likely not a seismic event » OR signal possibly contaminated by environmental conditions
 - Virtually all of the Qual A and B, and many of the Qual C have been identified by the *InSight* MQS as tectonic quakes.
 - Many (most?) of the remaining events are also likely tectonic in origin.
- Currently ~60% of *InSight* data and >90% of commands are being relayed through Odyssey, so naturally the *InSight* team shared concern about the potential loss of Odyssey as a relay asset due to the current budget situation (see below).
- A question was raised in the Q&A regarding the ability to distinguish between Mars quakes and impacts. Bruce's response was that differentiation is possible based on spectral characteristics. None of the high signal-to-noise events recorded thus far appear to have the characteristics expected for impacts. There is a paper in review about a small impact that occurred nearby.

MAVEN Project Status and Science Highlights

MAVEN Principal Investigator Bruce Jakosky [presented](#) on mission status, plans for Extended Mission-4 (EM-4), and recent science highlights. Recording of the presentation is posted [here](#).

- Spacecraft and instruments continue to operate nominally and to produce "Level 1" quality science measurements. No significant anomalies that affect science.
- Development planned for "all-stellar" mode using star trackers, as backups to IMUs.
- MAVEN is currently operating in EM-4, which runs FY20-22.
 - Funding approved and in place for FY20, planning proceeding for FY21 & FY22;
 - Significant budget cuts relative to 2019 Senior-Review proposals require significant downsizing of the science team, starting this year and continuing each year into the future as further reductions bring the mission to its "science floor".
- Aerobraking successfully carried out in 2019 to reduce apoapsis from ~6200 to ~4500 km altitude which improves relay performance, including direct coverage of Mars 2020 EDL
- MAVEN arrived in orbit at Mars after the peak of the solar cycle and is currently observing at solar minimum. A new cycle is beginning and will reach solar max in ~2025, so observations through 2025 will include first observations of atmospheric response during the rise and peak of the solar cycle.
- Several science highlights and publications shown in the [slides](#).

Mars Reconnaissance Orbiter

Project Scientist Richard Zurek gave a [presentation](#) on the Mars Reconnaissance Orbiter (MRO) recent highlights and future plans. Recording of the presentation is posted [here](#).

- MRO spacecraft is healthy and all subsystems are operating as required;
- MRO proposal for EM5 was judged “excellent” by the Planetary Mission Senior Review
- MRO Science Objectives for FY21-26:
 - Complete Extended Mission 5 (EM5) in FY21-22; includes pursuit of 16 science investigations in 4 goal areas;
 - Conduct an approved Extended Mission 6 (EM6) in FY23-25 with similar science goals as in EM5, with a focus on change detection.
- MRO also continues to provide MEP Program support including high-volume relay for surface platforms, landing site characterization, coverage of mission critical events (e.g., EDL), and providing environmental data needed for mission design and operations.
- Overview of science highlights can be viewed on the [slides](#).
- FY21 President’s budget implications:
 - The budget reductions proposed by the FY21 President’s budget will require a \$2.5M reduction across all science investigations and will put MRO at its EM5 science floor in FY21;
 - CRISM close-out would begin in FY21 and complete in FY23;
 - Of the 16 original EM5 science investigations, 4 could be completed, 4 cannot be addressed, and 8 must be reduced in scope;
 - For prior budget cuts, MRO reduced *analysis* of its acquired data, leaving analysis to the scientific community at large. With these proposed reductions, MRO will have to reduce the *collection* of data that it could otherwise take, starting in FY21.

Mars Science Laboratory Update

Project Scientist Ashwin Vasavada [presented](#) an update of Mars Science Laboratory *Curiosity* (MSL) current status, recent exploration, and future plans. Recording of the presentation is posted [here](#).

- 100% of the MSL science team has transitioned to teleworking.
- The MSL rover, payload, operations process, and team are capable of achieving the same quality and breadth of scientific analyses as at the end of the prime mission, with only a few exceptions. All of the science instruments are working.
- To date MSL has driven 22.2 km, gained ~410 m of elevation, and analyzed 25 drill samples.
- Curiosity is currently in Extended Mission 3 (EM3), which is expected to fundamentally advance understanding of the persistence of water and habitable environments in the early Hesperian, and will bring the rover to three key regions for the first time:
 - A clay-bearing unit (in progress in FY20);
 - The clay-sulfate transition and sulfate-bearing unit;
 - The Greenheugh pediment and Gediz Vallis ridge.
- The scientific merit of EM3 was rated as 5 out of 5 by the 2019 Planetary Mission Senior Review; and overguide funding was recommended.
- FY21 President’s budget implications:
 - Since FY20, funding limitations have resulted in unused rover and team capacity;

- The mission is behind on proposed EM3 science after the unexpected 13% budget cut in FY20. Additional 20% cut proposed in the President's budget would severely reduce the number of planning cycles the mission can support, which directly translates to reduced driving and sampling;
- Reduced operations will push FY21 science objectives to FY22 and beyond, for which there is no funding in the President's budget for MSL. Even if further funds were provided then, the slower pace necessitated by the FY21 cut, combined with the known power degradation of the RTGs, could jeopardize the ability in later years to explore the rocks recording a (*the?*) major climate transition on early Mars.

Mars Odyssey

Project Scientist Jeff Plaut [presented](#) a status report on the Mars Odyssey mission (ODY).

Recording of the presentation is posted [here](#).

- ODY in the first year of a three-year Extended Mission #8 (EM8)
- Spacecraft and mission operations are green across the board.
 - 3 of 4 reaction wheels are functional;
 - 10 years of fuel remain;
 - Instruments are operating nominally with no degradation.
- ODY is the only orbiter with consistent morning dayside and post-sunset coverage, and is a major element of the communications infrastructure (e.g., ODY relays the majority of data from, and commands to, the *InSight* spacecraft).
- Senior Review gave ODY a favorable review and recommended an increase in funding over the proposed level.
- ODY's science goals and advantages are presented in the [slides](#).
- FY21 President's budget implications:
 - ODY's budget is reduced from \$11.7M in FY20 to \$1M in the FY21 President's budget;
 - To closeout in October FY21 requires shutting down starting this spring;
 - This would terminate ongoing science investigations by THEMIS and the Neutron Spectrometer and High Energy Neutron Detector, and the termination of scientific research projects at universities, research facilities, and NASA centers, including withdrawal of funding for graduate and undergraduate students;
 - Would also eliminate support at ASU for DPS sub-node, JMARS data analysis tool and widely-used Mars image data retrieval tools;
 - Would end ODY's role in the communications infrastructure for landed assets at Mars.

Mars Architecture Strategy Working Group (MASWG)

Bruce Jakosky, in his role as MASWG Chair, [presented](#) an update on the current status of the working group, including a listing of community perspectives, issues, and concerns relevant to MASWG. Recording of the presentation is posted [here](#).

- MASWG is chartered to address the following tasks:
 - Determine what could and should be done beyond (i.e., in addition to or after) the Mars Sample Return campaign;

- Survey the compelling science addressable by various classes of missions during the period 2020-2035, building on the science goals outlined in *Vision & Voyages* and updated in the MEPAG Goals Document;
- Define mission candidates in various mission classes to guide future MEP planning including, but not necessarily restricted to, missions in the small-spacecraft, Discovery, and New Frontiers categories, which may also be considered by the upcoming Planetary Decadal Survey (2023-2032);
- Define strategic technologies, infrastructure, and partnerships (international and commercial) that can enable compelling science in the specified time horizon, showing their programmatic linkage.
- MASWG next steps:
 - MASWG meeting April 20-22 to discuss preliminary findings;
 - Preliminary report (ppt) to be released for input and feedback, with external review by selected members of the Mars community, a briefing at NASA HQ and JPL, and a brief to MEPAG (likely via a virtual meeting with a web mechanism to allow written feedback);
 - Will provide results to the DS Steering Committee and relevant sub-committees upon request; Executive Summary may be provided as a white paper.

MEPAG Findings Old & New

The meeting concluded with a [discussion](#) of findings for the MEPAG 38 Meeting, led by MEPAG Chair R. Aileen Yingst. Seven new findings addressed:

1. Major progress in the formulation of the next MSR campaign flight missions;
2. Efforts to update the Planetary Protection procedures and documents;
3. The recommendation to form a Mission Design Team to review the mission objectives and to define appropriate instrumentation; the concern for additional instrumentation to address ice science objectives;
4. The concern regarding substantial reduction of funding for highly rated extended missions;
5. A systematic approach to sustaining a communications infrastructure at Mars;
6. Increased funding for R&A in future years;
7. The progress and heroic efforts of NASA and the international community in their efforts to sustain, launch and develop missions to explore Mars.

The detailed findings can be found on the MEPAG website [here](#).