BROWN

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Dear Sean: March 11, 2009

The purpose of this letter is to report on MEPAG's meeting of March 3-4 in Rosslyn, VA. Attendance at the meeting was about 150 in person, including representatives from multiple NASA centers, NASA-HQ, academia, government, contractors, the press, and several foreign space agencies (ESA, CNES, JAXA, CSA, and Australia). We also webcast the meeting using WebEx, and >130 additional people logged in using this means. Finally, we made a concentrated effort during this meeting to move as many of the materials used during the presentations out to the publicly visible MEPAG web site either before or during the meeting, and this significantly improved the meeting's visibility and interest to the press.

Key discussion topics for the meeting included:

- Discussion of NASA's Mars program status and progress of international Mars exploration.
- MEPAG Inputs to the Decadal Survey.
- Discussion of notional architectures for the MEP through 2024.
- Update of the MSO SDT and discussion of the 2016 opportunity
- Planning for future MEPAG work.

We expand upon these items in the following paragraphs.

1) **Mars exploration status, discussion**.

- NASA. The slip of the launch of MSL from 2009 to 2011, priorities to meet the technical challenges of getting MSL to the launch pad, the implications of the slip on other elements of MEP, and opportunities for international collaboration were the focus of Doug McCuistion's presentation. As is well known to the Planetary Science Subcommittee, MSL's slip is expected to cost $400 million. The costs will be largely borne by the MEP with minimal impact outside the program. But this severely constricts funding in the MEP for technology development in the next few years. Thus the options for 2016 and 2018 are significantly constrained. McCuistion described the current ESA-NASA efforts to evaluate a possible joint program beginning with ExoMars in 2016. Michael Meyer provided a science update, emphasizing the increased potential habitability of Mars evinced by the observed variability of methane in the atmosphere, the recent evidence of water flows on Mars and the possible role of obliquity change. The underlying theme: Mars has the potential for life and we have the opportunity to pursue that possibility coming into the next decade.
- ESA. Dr. Jorge Vago provided an update of ESA's activities in Mars Exploration. ESA's plans for Mars include ExoMars as well as a new technology development program. However, the costs for ExoMars exceed available funding and international collaboration, particularly with NASA, is highly desired. This is being explored in the joint NASA-ESA studies described by McCuistion. Dr. Vago also updated MEPAG on the status of ExoMars. It is undergoing review of its key elements including instruments with key decisions to be made this spring.

- CSA. Dr Alain Berinstain, Director, Planetary Exploration and Space Agency, presented a new Exploration plan under development in Canada. Building on current participation in NASA's Mars Science Laboratory and Phoenix missions, and the contribution of the Canadarm to ISS, this has goals of participation in international Mars Sample Return and in human exploration of the moon. The plan includes Canadian contributions to earlier international Moon and Mars missions. The Government of Canada economic stimulus package presented in Canada's recent budget includes funds targeted at development of terrestrial prototypes of a Mars lander and lunar rover.
- Japan. Dr. Sho Sasaki described JAXA's on-going planning activity on their MELOS (Mars Exploration with a Lander and Orbiters) mission concept, which may be a candidate for the 2018 launch opportunity. They are interested in three primary scientific objectives:
  - Escaping Atmosphere: to understand how Mars atmosphere has evolved
  - Meteorology: to understand what is going on now
  - Interior Structure & Surface Environment: to understand how the solid body affects the atmosphere

3) **Analysis of MSL's possible outcomes, implications for next lander mission**. MSL will pursue fundamental questions of habitability and whether the environments accessible to the rover have high potential for the preservation of organic compounds and thus possibly evidence pointing to life. The outcome of MSL could indicate whether a follow-up mission should return to the same site or visit a different site and will also inform future capabilities for acquiring and analyzing samples. The MEPAG discussion indicated that the most robust exploration strategy would employ a follow-up rover that visits a different, new site. Few voiced support for an alternative fixed lander that deploys a drill for ~2m subsurface access, first because even short-range mobility may be crucial to choosing a drill site and second because the results of the ExoMars drilling experiment will not be known before 2017. As discussed at previous MEPAG meetings, a rover should measure elemental abundances and mineralogy sufficient to characterize past environments. The key measurement requirements for the follow-up lander/rover mission should be identified as soon as possible, recognizing that the payload will probably be smaller than that of MSL. Ideally, the follow-up rover would demonstrate elements of sample caching; in all cases the designs of future landers/rovers should address planetary protection requirements. These considerations underscore the need to re-start the development of technology for future lander/rover and sample return missions as soon as possible.

4) **MSO-Update**.
Dr. Michael Smith, the chair of the Mars Science Orbiter SDT, presented a summary of recent discussions of the MSO SDT in response to the now published detection of methane in the atmosphere of Mars, and the reduced funding available for the 2016 mission opportunity. Prior to the slips of the Mars Scout (now MAVEN) and MSL to 2013 and 2011, respectively, the MSO SDT had identified 5 primary objectives for a 2013 orbiter mission:
1) Atmospheric Composition; 2) Atmospheric State; 3) Surface Change Science; 4) Site Certification Imaging; and 5) Telecom Support. Reduced funding due to the MSL slip and possible collaborations with ESA on ExoMars make it clear that not all these objectives can be accommodated for 2016. The MSO SDT found that a mission focused on trace gases was a scientifically important mission that could be flown within the expected $700M budget and

would follow up the methane detection and its associated implications, while characterizing the chemical nature of the Mars atmosphere and its four-dimensional interactions with the subsurface. This could be done by focusing the mission on: 1) Atmospheric Composition: A sensitive and comprehensive survey of the abundance and temporal and seasonal distribution of atmospheric species and isotopologues (including methane), and 2) Atmospheric Climatology: Providing new observations that constrain and validate models, extend the present record of martian climatology, and provide correlative data (e.g., dust concentration, water vapor) needed to understand the photochemical role of aerosols. If resources permit, the next priority would be to add back mapping of key tracers. The MSO SDT also endorsed telecom support for future landed missions.

The community strongly supported the goals of MSO in the 2016 opportunity but questioned the lack of high-resolution imaging capability. MRO is currently the only asset with the capability (sub-meter resolution) to perform landing site certification, and this might be needed for site selection for future landers including elements of MSR and networks. This raised the issue of how best to use the current missions (Mars Odyssey, MRO, Mars Express) for selecting sites for future missions.

5) **Mars Program architecture planning**.

Dr. Phil Christensen, the chair of the Mars Architecture Tiger Team -3, reported on the status of the recent MATT-3 study. The objective of this study was to review the program goals, guiding principles, and mission building blocks, and to assess the Mars Program architecture in light of the MSL launch slip and the resultant reduction in funding for the 2016 launch opportunity. The MATT-3 specifically assumed a NASA-only program in its deliberations. The MATT-3 found that the underlying goals of the program remain unchanged, and formulated architecture with a scientifically balanced program that builds to Mars sample return at the earliest achievable opportunity. MATT-3 did add a guiding principle to specifically address the need to control costs and cost risk in the Mars Program. This control can be achieved while still making progress on science objectives by utilizing the technology investment of MEP (landing systems, orbiters, aeroshells, and rovers) as much as possible for future landed missions, and by not taking on too many technological objectives in any one Mars mission, while continuing to make real progress toward Mars sample return.

The MATT-3 team evaluated possible architectures that could support our high-level scientific goals. This included input from the MSO SDT (see above), whose findings were endorsed by the MATT-3 group.

Given the conditions of an MSL launch slip to 2011 and reduced funding for the 2016 mission, the preferred architecture suggested by MATT-3 is:

- Now: Start a technology program focused on developments that enable MPR and feedforward to Mars sample return
- 2016: Launch the Mars Science Orbiter (MSO-lite) to investigate trace gases and atmospheric state and provide telecom support
- 018: Launch Mars Prospector Rover (MPR) to a new site
- 2020: Launch Network Mission (NET)
- 2022-2024: Launch MSR-Lander and MSR-Orbiter

This architecture accomplishes the previous Decadal Survey high priority mission goals (aeronomy, network, sample return) while responding to recent discoveries by the Mars Exploration Program.

MATT-3 had three specific suggestions for future action by MEPAG. First, the implications of potential MSL and ExoMars results need further study in order to define the suite of possibilities for the landed mission in 2018. Second, MEPAG should study the need and focus of a new "vertical sampling" mission building block. Finally, MEPAG should consider how best to prepare for the selection of future landing sites; specifically to discuss how and when a landing site selection process should be established to best utilize the existing missions for the future program?

The community was broadly supportive of the architecture analysis put forth by MATT-3 and in particular the need for a program and to build, through the next missions, towards sample return. There were some different perspectives expressed such as "Could the 2016 opportunity be competed as a Scout?" and "Could the 2016 payload and science objectives be competed?" These were considered interesting and intriguing options, but the need to make sure that critical MEP assets (e.g. telecom) were secured by an orbiter in 2016 diminished the attractiveness of these options.

6) **Mars-Forward Lunar Planning.** MEPAG's sister organization, LEAG, is in the process of preparing their version of a master Goals Document. They have defined three high-level themes, the second of which is to "Use the Moon to Prepare for Future Missions to Mars and Other Destinations". The LEAG Chair, Dr. Clive Neal, has invited MEPAG's input on the draft planning for this theme, which was presented at the meeting, and which is posted for reference on the MEPAG web site.
   - Within Theme 2 there are two Goals, referred to as Goal 2A (Identify and test technologies on the Moon . . .) and Goal 2B (Use the Moon as a test-bed for mission operations. . .).
   - Goal 2A has nine Objectives, each of which has from 2-7 Investigations. This mostly relates to testing hardware.
   - Goal 2B has two Objectives, each of which has from 4-5 Investigations. This mostly relates to testing operations.

   All MEPAGers are encouraged to review the above hierarchy, the descriptions of the investigations and objectives, and the assessments of priority. Any comments should be returned to jeffvolosin@verizon.net.

7) **MEPAG Goals and Decadal Survey.** Goal IV (Preparation for Human Exploration) of the MEPAG Goals Document is expected to undergo revision this summer coincident with the upcoming release of the Design Reference Architecture 5.0 document. The process for initiating and completing this update during the next several months was discussed by Abhi Tripathi. The Goals Committee will also consider how the recent atmospheric methane discovery affects the priorities and content of the Goals Document.
   The MEPAG Goals Committee was charged with developing a short (3-5 page) white paper to discuss how the Goals, Objectives, and Investigations of the MEPAG Goals Document intersect with the cross-cutting themes from the 2003 Decadal Survey: *The First Billion Years*

of Solar System History; Volatiles and Organics: The Stuff of Life; The Origin and Evolution of Habitable Worlds; and *Processes: How Planetary Systems Work.* This document will be completed by June 1, 2009.

8) **Mars-Themed Workshop/Conference Reports.** Summaries were presented of five Mars-themed conferences held since the last MEPAG meeting. The topics covered included Mars atmospheric modeling, Mars sample return, Mars ancient valley networks, dunes, and phyllosilicates on Mars. Some of these conference reports included statements of consensus positions, some consisted of concluding perceptions by the conveners, some represented synopses of the material presented, and some contained suggestions for future mission planning. The depth of penetration of key Mars science issues and the level of engagement of the Mars community were impressive. All of these workshop reports are now posted on the MEPAG web site for the benefit of those who were unable to attend.

9) Planning for future MEPAG work. MEPAG is planning to hold its next meeting on July 29-30, 2009, in Providence, RI. In the ~4.5 months between now and then, MEPAG plans the following activities:

- Prepare to provide inputs to the Decadal Survey;
- Continue MATT-3 activity as the 2010 budget and additional science and mission details become available.
- Form a Science Analysis Group to analyze the science goals of the next landed mission (tentatively 2018);
- Form a Science Analysis Group related to subsurface access (this activity is of lower priority for the July meeting);
- Form a Science Analysis Group to consider the structure, activities, and potential benefits of a Mars Climate Modeling Center
- Prepare an update to MEPAG's Goal IV. However, this activity is on hold until Mars Design Reference Architecture 5.0 is made available;

For each of the above four activities, volunteers from the Mars community were solicited to staff the study teams (and this offer extends to those who were unable to participate in person).

One of the discussion topics that repeatedly came up during the course of the meeting is the value of exploring Mars through a strategically planned program of interdependent missions. There is a strong consensus among the community that this has been an essential foundation of the Mars Exploration Program's striking success over the past decade. This has allowed us to make progress on very high-order questions that are too complex to address in a single mission, such as understanding the current state and evolution of Mars as a planet and assessing if, when, and where it was ever habitable. The strategy of using interdependent missions has been essential in managing risk and cost and in maximizing the overall science productivity of our Mars spaceflight activities. The MEP is now poised to move beyond the strategy of "Follow the Water" to the deeper and even more difficult question of "Did Life ever exist on Mars." The need to continue managing Mars exploration through a strategically linked program of missions will be as important over the next 1-2 decades as it has been over the past decade, and it is exceptionally important that this continue.

Sean, please don't hesitate to contact me if you have any questions.

Sincerely

Dr. John F. Mustard

Cc: Doug McCuistion
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Joyce Pulliam, for forwarding to the MEPAG mailing list