BROWN

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Dear Dr. Greeley: April 6, 2010

This letter reports on MEPAG's meeting of March 17-18, 2010 in Monrovia, CA. Attendees at the meeting numbered about 150, including representatives from multiple NASA centers, NASA-HQ, academia, government, contractors, the press, and several foreign space agencies (ESA, CSA, JAXA, CNES, DLR). WebEx was used to webcast the meeting, and all of the materials used during the presentations have been made available to the larger community through the MEPAG web site (http://mepag.jpl.nasa.gov/).

Key discussion topics for the meeting reflected ongoing developments related to the Mars architecture previously endorsed by MEPAG. This included status reports on the emerging NASA-ESA joint mission initiatives for Mars, the work of the NRC's Decadal Survey's Mars Panel, as well as early exploration of possible interactions with NASA ESMD as it considers possible precursor missions that may pave the way to future Mars human missions. These topics were also considered in the context of new work by the MEPAG Goals Committee, which proposed updates of MEPAG's Goal I (Life) and Goal IV (Preparation for Humans) objectives and investigations. Detailed presentations on the proposed MAX-C and ExoMars rovers and the overall MSR 3-flight element architecture set the stage for a report by the 2-Rover iSAG on the potential scientific synergy between the two 2018 rovers and the final report by NET-SAG on the priorities for network science. These and other items are described in more detail in the following paragraphs. Key points are highlighted in bold text.

1. **Mars exploration status, discussion.**
   - NASA. Doug McCuistion provided an overview of NASA's activities related to Mars, including the emerging joint program with ESA, the potential opportunities associated with the new Office of the Chief Technologist and with the on-going refocusing of the human space exploration program. The developing management structure for the NASA-ESA joint initiatives in Mars exploration was described; this emphasized joint participation in the science, engineering, and management processes.

   - ESA. Marcello Coradini presented an overview of ESA's perspective on the proposed joint NASA-ESA 2016 and 2018 missions.
     - The 2016 mission combines a joint orbiter payload (now being solicited, so not discussed publicly), an Electra relay package, and an Entry, Descent and Landing (EDL) Demonstration Module (EDM). The EDM is principally a technology demo, capped at 600 kg, and short-lived (8 sols on batteries). Within these constraints, it is not known if scientific instruments can be included; if they are, there will be a joint announcement opportunity released in

the summer.

- The 2018 mission combines two rovers: the ExoMars Rover, which is designed to demonstrate key technologies (roving, drilling) and conduct astrobiology-related in situ science, and the MAX-C Rover which is conceived to provide a scientifically credible cache for sample return and to conduct in situ science with an augmented MER-class payload (also needed for sample selection). The ExoMars Rover and its payload are relatively far along in the design process and that presents a challenge in the development of the combined mission.

- Discussion: Most of the discussion following these presentations centered on the proposed joint NASA-ESA activities. These are truly joint missions with each partner sharing the critical path to success. There are clearly advantages to such collaboration, including developing a strategic mission for the 2016 launch opportunity. However, challenges were also noted.

Concerns re: NASA-ESA Joint Missions

- The 2016 Orbiter mission has an ambitious program of scientific and technical objectives within a highly constrained resource box. There is concern that, without dedicated effort on the part of both NASA and ESA, the mission's ability to address its compelling scientific objectives will be compromised during the development phase.
- The agenda for deploying the MAX-C and EXM rovers to the same place needs work (see Section 3).

2. NRC Decadal Survey Mars Panel Update.

Phil Christensen provided an update on the activities and inputs to the NRC report by the Decadal Survey's Mars Panel. He noted that the Mars Panel utilized information from recent MEPAG study teams as well as from the numerous white papers they received. Objectives for the next decade (not in priority order) are to fly a Trace Gas Orbiter designed to explore numerous minor species, begin Mars Sample Return with a rover that will cache a well selected suite of samples, and develop a geophysical/atmospheric network. These are aligned with the goals and objectives outlined in MEPAG's Goals Document. The D/S Steering Committee invited and received in February a half-day presentation from the Mars Program Office on the strategy and technology associated with a 3-flight-element Mars Sample Return campaign. The next Mars panel meeting will be held in April in Boulder with the panel working in closed session to finalize their input to the steering committee. The steering committee will have two more meetings in July and September to create its final report before it undergoes external review.

3. Report of the 2-Rover iSAG.

In late 2009, MEPAG chartered its first "iSAG" (international Science Analysis Group), with equal participation from scientists supported by NASA and ESA. Co-chaired by John Grant (USA) and Francis Westall (UK), this team was asked to evaluate the possibilities for cooperative science using two rovers at the same site from two perspectives:

- No hardware change; i.e., take the ExoMars and MAX-C rovers as currently proposed;
- Some hardware change: Given some leeway with changes to of MAX-C, and with lesser leeway of ExoMars (further advanced in design), what additional science could be done?

The team pointed out that in either case there could be at least two potential areas of conflict:

- Cooperation between rovers could require extra time, which could compromise their current individual objectives;
- Sharing a landing site has multiple implications that could require compromises.

The MEPAG audience had a very energetic discussion of this report, which concluded with acceptance of the report and the desirability of its recommendations.

Findings: **2-Rover iSAG**

- Ensure that the 2018 landing system is able to access mixed-terrain sites with internal hazards. Cooperative science options are unlikely to be meaningful if this mission only considers "go-to" sites.
- Determine if it is possible to improve the ExoMars and MAX-C sample transfer systems to allow a subsurface ExoMars sample to be returned to Earth.
- Co-located rovers will introduce a telecommunications bottleneck. Increase telecommunication sessions to twice per sol for each rover (note that it is likely that the most efficient way to solve this is by making a change to the 2016 Orbiter).
- Extend ExoMars' roving capabilities to ~10 km, and its nominal life time from 180 to 360 sols.

MEPAG notes that the feasibility of these features and their priority relative to other mission capabilities were not discussed. The 2016 and 2018 missions are already struggling with tight technical and financial margins.

This international SAG was able to wrestle with tough problems, identify possible options and to prioritize where necessary. MEPAG felt that this and the 2016 Joint Instrument Definition Team, which reported at earlier MEPAG meetings, have clearly demonstrated viable paths for scientific input to these joint Mars missions from the international Mars community. MEPAG intends to pursue such collaboration in its future studies.

4. <u>Report from the MEPAG Goals Committee.</u>

MEPAG Goals Committee Chair Jeff Johnson presented an overview and history of the Goals Document and an introduction to the current revisions to Goals I (*Determine if life ever arose on Mars*) and IV (*Prepare for human exploration*). Tori Hoehler and Frances Westall (Goal I representatives) prepared a draft revision, this was then iterated in detail with a 15-person review committee (including 6 members from the European Mars community) organized by David DesMarais and the NASA Astrobiology Institute Mars focus group. In addition to feedback generated at the MEPAG meeting, the draft was open for written community feedback until March 31, 2010. For Goal IV, MEPAG

organized a small SAG under the leadership of Abhi Tripathi and Darlene Lim (Goal IV representatives) to prepare a revised version of Goal IV. With the release of the Design Reference Architecture (DRA 5.0) last fall, this group convened on November 1, 2009 and held telecon discussions through February 2010 to reorganize the Objectives, Investigations, and Measurements in Goal IV. A proposed updated version was presented to MEPAG, and also posted to the MEPAG website for written community comments through March 31, 2010. Key changes are noted below.

- **Goal I update:** Goal 1 has been reworked to reflect the changes in our understanding of the history of Mars over the past decade and its potential to host life. In the new document the search for life has been subdivided into two objectives: Objective A - the search for traces of extinct life, and Objective B – the search for extant life. Given the environmental conditions at the present surface of Mars and the present technological constraints, Objective A is of higher priority. Investigations within each objective relate to evaluation of the habitability of the materials under investigation, evaluation of the potential of these materials to preserve traces of life and, finally, the search for evidence of life. The investigations are presented not in order of priority but rather in order of strategy, knowledge of the habitability and preservation potential of the materials being essential to the search for traces of life. A final Objective, C, is to understand the long term effects of planetary evolution on habitability and possible prebiotic chemistry. An appendix has been added to define terms, including life itself, habitability, biosignatures and contamination, and the preservation of evidence for habitability and/or biosignatures.

- Goal IV updates: Goal IV investigations are conducted by robotic spacecraft at Mars to prepare for the first human missions (or set of missions). Examination of the impact of recently collected data on the previous Goal IV assessment was followed by evaluating the value of additional precursor data in increasing safety and performance and decreasing cost and risk of these first human missions. For Objective A (acquiring the knowledge needed for human missions), 9 of the 10 previous investigations were judged to still be important, although the priorities of these investigations has evolved. The top two investigations relate to understanding the atmospheric environment to be able to achieve safe EDL with high mass landing systems, and understanding the risk of back planetary protection. No new investigations were added to the list. Objective B (technology demonstrations by Mars flight missions) was removed, with a recommendation that a separate technology demonstration roadmap be constructed to identify critical technologies which should be proven in a "flight-like" environment.

Reactions by the MEPAG community on Updates to Goals I & IV:

- The updates were favorably regarded. The Goal I updates were essentially complete, having benefited from extensive review. Goal IV may need more work, in light of the new technology thrusts and ESMD work on robotic precursor

missions for human exploration. MEPAG (and SMD) should facilitate interactions with ESMD.
- There was strong agreement that a separate technology demonstration roadmap should be produced to provide rapid feedback to ESMD on precursor mission requirements (this would be a successor to Goal IVB);
- A number of high-level products could be produced if there were funded opportunities established to apply past, present, and future science data to specific Goal IV investigation topics.
- Basic meteorological measurements (temperature, pressure, wind) should be competitively solicited for every lander/rover for both science and reduction of risk to future missions. *A key point is that meteorological measurements by the 2018 rovers would be* ***exactly*** *at the place that the Mars Sample Return lander/MAV/Fetch Rover would have to land and operate.*

5. <u>Report from the MEPAG NET-SAG.</u>

The final report of the Network Science Analysis Group (NetSAG) was presented by one of its co-chairs, Bruce Banerdt. NetSAG was chartered in 2009 to develop consensus-based analyses of several aspects of a potential Mars geophysical network mission, including a prioritized list of martian interior science goals, the science return related to these goals as a function of the number of network nodes (including, at its limit, one node), and required network lifetime. Starting with a list of scientific goals, they concluded and MEPAG concurred that:

<u>Finding: NET-SAG</u>
- Geophysical measurements, particularly seismometry, from a network of landed stations would provide a major advance in understanding the Mars interior and the evolution of its surface climate.
    - 4 stations are required to fully address the geophysical science objectives
    - 2 stations could substantially address the science objectives
    - 1 station would provide key information on interior structure and processes.

An operational lifetime of 1 Mars year would be needed. The team also presented supporting conclusions regarding complementary mission science (particularly meteorology), implementation needs (such as operational lifetime, landing precision, landing site requirements, and estimated costs), and technology development needs.

6. **<u>Planning for future MEPAG work.</u>** MEPAG tentatively plans to hold its next meeting on Sept. 30-Oct. 1, 2010, also in Monrovia, CA. This meeting will be on the Thursday and Friday of the same week as the 4th MSL Landing Site Workshop, and at the same venue. It is hoped that by putting the two meetings together, it will help minimize travel for the community, and encourage attendance at both meetings. Prior to that meeting, MEPAG may initiate a number of studies.

<u>MEPAG Future Work</u>
- Start planning for a MEPAG meeting in Europe in the spring of 2011, as a way to further advance cooperation on joint ESA-NASA missions.

- Continue work on developing common objectives, requirements and opportunities for the 2018 joint NASA-ESA mission.
- Consider a framework for mapping end-user sample return requirements (i.e., from a sample return *campaign* perspective) onto the individual flight elements, including definition of site criteria for 2018 reflecting the top-level sample return objectives.
- Follow-up (although perhaps not immediately) in collaboration with ESMD on the development of a humans-to-Mars roadmap that will be the successor to our current Goal IVB.

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

Sincerely

Dr. John F. Mustard

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