



John F. Mustard  
Professor  
Department of Geological Sciences

Dear Dr. Bagenal:

August 6, 2009

The purpose of this letter is to report on MEPAG's meeting of July 29-30 at Brown University in Providence RI. Attendance at the meeting was about 110 in person, including representatives from academia, multiple NASA centers, NASA-HQ, government, contractors, the press, and several international scientist including representatives of foreign space agencies (ESA, CSA). We also webcast the meeting using WebEx, and >70 additional people logged in using this means at some point during the meeting. Materials used during the presentations were posted to the larger community through the MEPAG web site either before or during the meeting, and this significantly improved the meeting's visibility to the planetary science community and increased the accuracy of what was reported about the meeting.

Key discussion topics for the meeting included:

- Discussion of NASA's Mars program status and progress of international Mars exploration, including discussion of ESA-NASA joint missions
- Reports on Future Science Missions
- MEPAG Inputs to the Decadal Survey
- Topical white papers from the community as input to the Decadal Survey
- Planning for future MEPAG work.

We expand upon these items in the following paragraphs.

**Highlights from the meeting included:**

- **Re-affirmation of the strategic priority of MSL within MEP.**
- **Exciting new proposals for a joint ESA-NASA program of Mars Exploration**
- **SAG report on a scientifically compelling landed rover for *in situ* exploration and sample caching**
- **Presentation of numerous white papers for the Decadal Survey**
- **General consensus at the meeting on an integrated strategy for Mars within the context of Solar System exploration, emphasizing the return of samples from Mars.**
- **The need to begin a formal program of site selection for sample return while key orbital assets (ODY, MEX, MRO) are still available.**

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

- NASA. Doug McCuistion, Director of the Mars Exploration Program (MEP), provided an overview of the MEP, focusing on Mars Science Laboratory (MSL) development and budget issues, and on the developing initiative between NASA and the European Space Agency (ESA) for the joint exploration of Mars. MSL continues its development, making progress on important technical issues and is on track for a 2011 launch. However, additional resources are required (\$15M-\$115M) to restore the reserves needed to complete the mission. These additional costs will be borne by future obligations in the MEP, affecting

technology development and the scope of NASA Mars missions in 2016-2020. Should the costs exceed what can be accommodated by MEP in the short term, delays are then probable in future lunar missions (LADEE and ILN) as well as in selections for Phase B New Frontiers and in Discovery mission opportunities. A MSL readiness-to-proceed review will be held in November. Over the past 6 months ESA and NASA have been in discussions to define a joint Mars program. This has led to the establishment of a Joint Engineering Working Group (JEWG) and a Joint Executive Board. A Joint Instrument Definition Team (JIDT) had previously been formed to define a payload for an orbiter that would carry the ExoMars rover in 2016. At a bi-lateral meeting in June, NASA and ESA agreed in principle to a joint exploration initiative involving an orbiter in 2016, landed science in 2018, and working towards additional goals in 2020. ESA's ExoMars rover would move from 2016 to the 2018 opportunity as part of the joint mission (to be studied). The overall objective would be to return samples in the 2020's. A series of intense studies are ongoing with the goal of presenting more details of a joint proposal to the Decadal Survey's Mars panel in September and to the ESA Council Meeting in October.

- ESA. Dr. Marcello Coradini provided an update of ESA's activities in Mars Exploration. Dr. Coradini focused on the joint ESA-NASA plans reiterating the goals of an orbiter in 2016 focused on trace gases and an activity in 2018 that fulfills the ExoMars goals and NASA's landed science objectives. The joint effort in 2018 would likely use the NASA sky crane landing system but ESA wishes to develop Entry Descent and Landing (EDL) technology. Dr. Coradini thus presented the concept of a modest demonstrator EDL package with a small science payload. He also showed the current configuration under consideration for the ExoMars rover where the instrument package has been descope to eight, restoring adequate mass margin for development. Finally Dr. Coradini spoke about the beginnings of a Mars Robotic Exploration programme to be conducted in collaboration with NASA and with one objective being Mars Sample Return.
- MSL Reaffirmation: Dr. Michael Meyer gave an update on the MSL science capabilities, development and future activities. The mission is retiring risk and moving ahead to the launch in 2011. Critical areas of concern remain with the avionics and actuators, but these are being worked. Most of the instruments have been completed, but SAM still requires rework. MSL is being reviewed regularly by NASA with a Readiness-to-Proceed review planned for November. There is a call for a potential 5<sup>th</sup> landing site to be evaluated in October. The technologies that are core parts of MSL EDL are critical for future landings leading towards sample return. The MSL science capabilities are key to making progress on many of the MEPAG life, climate and geological sciences goals, with MSL being the first mission to specifically go beyond the "Follow the Water" theme via its future examination of the habitability of a site chosen based on both morphological and compositional orbital data. *Discussion following the presentation re-affirmed the high strategic importance of MSL to the future scientific exploration of Mars. This is the right mission at the right time.*

## 2) Report from the MEPAG Goals Committee.

MEPAG's standing Goals Committee reported the following:

- Preparation of a 7-page white paper summarizing the Goals Document for the Decadal Survey
- Initial efforts on a revision to Goal I (led by Tori Hoehler and Frances Westall).

- Discussion of plans to open a major revision process for Goal IV (led by Abhi Tripathi and Darlene Lim). This has been delayed for many months pending the public release of Design Reference Architecture 5.0, which has now happened.

([http://www.nasa.gov/exploration/library/esmd\\_documents.html](http://www.nasa.gov/exploration/library/esmd_documents.html))

### 3) **Mid-Range Rover Science Analysis Group (MRR-SAG) briefing.**

MEPAG received a major report from the MRR-SAG. This international committee of 27 Mars experts has been working for about 4 months to develop the vision of a rover mission to be launched in the 2018 launch opportunity. The MRR-SAG committee considered two major factors besides the scientific drivers for the mission: 1) The range of possible and probable discoveries from MSL and MER, and the most effective ways to follow-up on those discoveries, and 2) The most important ways that a 2018 rover mission could contribute to MSR. The SAG concluded with the vision of a scientific mission to the martian surface that would have the following draft primary scientific objective: “At a site with high preservation potential for physical and chemical biosignatures, evaluate paleo-environmental conditions and access multiple sequences of geological units in a search for evidence of ancient life and/or pre-biotic chemistry. Samples containing the essential evidence would be collected, documented, and cached in a manner suitable for return to Earth by a future mission.” The implementation of this mission would include the capability to explore a new site that is selectable from orbital data, to select samples for possible return to Earth by a subsequent mission and to document their context. As such, this mission would be the first major step of sample return. This mission would have a rover size intermediate between those of MSL and MER.

### 4) **Joint Instrument Definition Team (JIDT).**

This team of European and US scientists, co-chaired by Augustin Chicarro and Richard Zurek (who presented) reported on their efforts to define an orbiter payload that would focus on atmospheric trace gases, as motivated by recent discoveries of methane on Mars. The challenge was to do this in a meaningful way within the constraint that this orbiter would also carry the 1200 kg ExoMars Descent Module into Mars orbit following a launch in 2016. The findings of the group were: 1) A broad, sensitive survey of possible trace gases and key isotopes was required to assess the nature of their sources; 2) detection needed to be paired with measurements of atmospheric aerosols and temperature, as heterogeneous and homogeneous gas phase photochemical processes will alter their atmospheric concentrations; 3) key species (e.g., methane and water) should be mapped at a resolution adequate to infer localized sources (assuming they exist), and 4) all this was unlikely to be accomplished within the stated allocation of 70 kg not-to-exceed. This work was accomplished before the NASA-ESA bi-lateral meeting in June (described earlier). The proposed joint program of exploration, with an ESA orbiter and international payload launched in 2016, with a drop-off technological demonstration package, provides an excellent opportunity to accomplish the twin goals of trace gas detection and mapping. Furthermore, the JIDT serves as an example of how critical science expertise can be injected into joint mission definition exercises.

### 5) **Decadal Survey and Community White Papers.**

Earlier in the meeting, David Smith and Phil Christensen provided the latest information on the Decadal Survey activities and schedule, including expectations about white papers. The MEPAG then heard from seven groups developing white papers for the Decadal Survey. This

provided a forum for the authors of white papers to present their ideas and solicit input from the larger MEPAG community. Engaging and thoughtful presentations were received on the ionosphere (Paul Withers), future landing site characterization (John Grant), polar energy balance and the CO<sub>2</sub> cycle (Tim Titus), polar science (Mike Hecht), landed meteorological investigations (Scott Rafkin), atmospheric science (Mike Mischna), and Mars technology planning (Samad Hayati). MEPAG also heard a report from a recent Planetary Society activity to explore the rationale and principles for a strategic program of Mars Exploration 2016-2032 from Jim Bell.

All the white papers presented at the meeting are also posted on the MEPAG web site. This is to facilitate wide distribution and to solicit further input. The Decadal Survey Steering Committee issued guidance that the level of community support in developing the white papers should be indicated. To clarify the roles of those involved in the paper development, and those that support the papers' themes and conclusions, the MEPAG recommended that "authors" refer to those who contributed directly to a paper's content while "signatories" be used to indicate support by members of the larger community. The signatory list will be maintained on the MEPAG website for reference by the Decadal Survey.

#### **6) Decadal Survey Discussions: Mars State of Knowledge and Future Directions.**

I (Jack Mustard) presented a report on the state of Mars knowledge, the value of a program to explore Mars, and the plans and strategies for the future. These summarized white papers being formed on behalf of MEPAG to address Decadal Survey topical areas. Our understanding of Mars has developed along all major disciplines under the theme Follow the Water. The report showed that a number of paradigms have shifted and previous assumptions challenged from the data collected by NASA and ESA missions over the past decade. These science results make Mars an even more compelling planet to explore as they have sharply focused hypotheses related to fundamental planetary science questions. Regarding the life question, the potential has increased for habitable ancient environments, given the diversity of aqueous environments discovered, while it still exists for modern life, given tantalizing hints of water activity on present Mars. I summarized the recent activities in the MEP and MEPAG to plan an engaging and plausible future MEP under the Mars Architecture Tiger Team (MATT) and the Mars Architecture Review Team (MART). The science goals (atmosphere, interior, geology, polar, etc.) for the next decade remain compelling. The challenge is implementation under constrained budgets. The MEPAG community expressed strong support for MSL and MAVEN, as well as the goals of a trace gas mission at the earliest opportunity and returning to the surface to explore the diversity of environments while taking the first steps to sample return through caching.

There was considerable discussion revolving around sample return. The community generally agrees that the most significant step toward achieving many of the MEPAG goals in astrobiology, geochemistry, geology and climate would be the return of samples from Mars with careful, comprehensive analysis in terrestrial laboratories using the most capable tools available. Because of its scope, it was suggested that MEPAG consider sample return as a campaign, consisting of the elements sampling/caching (MSR-C), launching to Mars orbit (MSR-L), and returning to Earth (MSR-O). Such a campaign provides a measured approach, providing branch points and flexibility that reduce both scientific and technical risk. In fact the MEP has been moving towards sample return for the past decade with its strategic and competed missions focusing the questions, defining compelling sites to explore for returned

samples and conducting in situ operations. However there was some diversity of opinion regarding focusing the next stages of the MEPAG around the life goal. Mars has much to tell us about planetary formation and evolution; e.g., much of its early history is preserved and accessible in its ancient crust and there is strong evidence for more recent, episodic climate change. Many felt that understanding Mars as a planet and a system must be strongly pursued in partnership with assessing habitability and seeking signs of life. Thus, it was apparent that the Mars community remains strongly in favor of sample return as framed within the architectures developed by recent MEPAG SAGs (ND-SAG, MRR-SAG, NET-SAG) which emphasize the need for carefully selected samples within a well-characterized context, but which also pursue—as resources permit—missions like the trace gas orbiter and surface networks (a high priority of the last Decadal Survey). These considerations emphasize the importance of missions with dual purpose (both an in situ purpose and an MSR purpose), such as the proposed MRR rover. The next chapter in the exploration of Mars (suggested themes: Assessing Mars as an abode of Life or Seeking Signs of Life) requires a systematic understanding of processes and context for the samples that will be returned.

- 6) **Planning for future MEPAG work.** MEPAG tentatively plans to hold its next meeting in the week immediately following LPSC, if this will help allow more international scientists to attend. In the 9 months between now and then, MEPAG plans the following activities:
- Finalize the MEPAG inputs to the Decadal Survey;
  - Complete the work of the MRR-SAG with a report and presentations to the Decadal Survey.
  - Complete the work of the NET-SAG with a report and presentation to the Decadal Survey
  - Initiate work on the revisions of Goal 1 and Goal IV in the MEPAG Goals Document, for discussion at the next meeting.
  - Develop a group to assess the science priorities for a joint ESA-NASA 2018 activity
  - Consider a MEPAG study activity related to MSR (to be discussed).

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

Sincerely



Dr. John F. Mustard

Cc: Doug McCuistion  
Jim Green  
Marcello Coradini  
Fuk Li  
Michael Meyer  
David Beaty  
Rich Zurek  
Joyce Pulliam, for forwarding to the MEPAG mailing list