



Reply to Attn of: 239-4

July 28, 2011

Ron Greeley, Chair  
Planetary Science Subcommittee  
Science Advisory Council  
School of Exploration  
Arizona State University  
Tempe, AZ 85287

Dear Dr. Greeley,

This letter reports on MEPAG's meeting, June 16 and 17, 2011 in Lisbon, Portugal. The attendees were truly an international group. The Mars communities were well represented from Europe (62 attendees) and North America (57 U.S. and 2 Canadian) and included several first-time participants. Several individuals attended from NASA HQ, NASA centers, ESA, other government (including space) agencies, academia, contractors, and the press. WebEx was used to web-cast the meeting, and virtually all of the presentation materials have been made available to the larger community through the MEPAG web site (<http://mepag.jpl.nasa.gov/>).

Key discussion topics addressed ongoing developments related to the Mars architecture previously endorsed by MEPAG. This included the NRC Solar System Decadal Survey Report as well as status reports on the emerging NASA-ESA joint mission initiatives for Mars, including the interim Joint Science Working Group (JSWG) and the Joint Engineering Working Group (JEWG). The End-to-End International SAG (E2E-iSAG) presented its final report on the architecture and key objectives of the MSR Program. Discussions of landing site selection addressed previous meetings by NASA (MSL sites) and ESA as well as the proposed NASA/ESA site selection process. These and other developments are described in more detail in the following paragraphs.

### **1. Solar System 2012 Decadal Survey and NASA implementation**

Phil Christensen provided an overview of the Solar System Decadal Survey and summarized its recommendations regarding Mars exploration. The NRC strongly endorsed the initiation of a sustained Mars sample return (MSR) campaign. The Decadal Survey ranked the 2018 sample collection rover, the first step in sample return, as the highest priority U.S. flagship mission for the coming decade. The NRC also strongly endorsed international partnerships to enable and enhance this program and, appropriately, left the details of its implementation to NASA and ESA leadership.

Michael Meyer summarized the NASA response to the Decadal Survey recommendations and their implementation via the NASA-ESA Joint Mars Exploration Program (JMEP). For the 2018 mission a single rover design can achieve a significant cost reduction by deleting the landed

pallet and thereby avoiding a major redesign of the MSL-derived EDL system. The joint ESA-NASA rover currently under study is base-lined to retain the ExoMars Pasteur scientific payload and subsurface drill. It is also base-lined to accommodate the NASA sample handling and caching system, along with the scientific instruments needed to select an outstanding sample collection. Following the division of responsibility established in their July 2009 Bi-Lateral meeting, NASA and ESA are proceeding with the joint 2016 Trace Gas Orbiter mission. The NASA portion of the 2016 mission is now in Phase-A. The NASA Mars Exploration Program (MEP) is continuing its early investment in Mars Ascent Vehicle technologies and, beginning in FY13, providing funding for the timely development of the other technologies required for the MSR campaign. The MSR Joint Engineering Working Group (JEWG) is determining which agency will lead specific technology developments. Finally, MEP has developed a proposal for an NRC study to include an analysis of technology needed for sample characterization and analysis within a Sample Return Facility.

## **2. Mars exploration program status**

- NASA/ESA Joint Mars Exploration Program (JMEP). Doug McCuiston and Jorge Vago summarized the organization and current status of JMEP. The joint program's initial missions for the 2016 and 2018 launch opportunities have been defined and both are integral parts of the joint program. The ultimate objective of the program is an international Mars Sample Return campaign.

The Joint Mars Executive Board (JMEB) is the governing authority of JMEP and provides guidance for formulating the missions and their requirements and the program architecture. JMEB also oversees mission implementation. The Joint Mars Architecture Review Team (JMART) independently assesses and critiques the program architecture, programmatic risk, national priorities, etc. The Joint Engineering Working Group (JEWG) develops cooperative architecture options for shared mission responsibilities and currently it is developing design options for the joint rover for the 2018 launch opportunity. Joint study groups define the scientific goals, objectives and specific measurement requirements of individual missions. For example, a Joint Instrument Definition Team laid the groundwork for last year's 2016 Trace Gas Orbiter Announcement of Opportunity, and an interim Joint Science Working Group (JSWG) did the same for the 2018 joint rover. The co-leaders and membership of these groups are drawn from both the North American and European communities.

At the March 2011 Bi-Lateral meeting, NASA and ESA agreed to pursue 2018 as a joint single-rover mission concept. The design study should be completed by the end of September. Phase C/D (for the U. S.) is scheduled to begin in July 2012. In May 2011 JMEB directed the JEWG to focus on design concepts for further study (see JSWG and JEWG discussion, below).

By June 2011 ESA had negotiated a price agreement with industry to implement the 2016 ExoMars TGO mission, which was to begin Phase C/D this July. Subsequent to the MEPAG meeting, this was put on hold awaiting a NASA letter of commitment for the joint program, which in turn had become enmeshed in discussions with OMB. (Apparently this became part of an overall discussion about all potential future flagship missions.) Resolution of this is expected by September. Meanwhile, the DREAMS science payload for ESA's 2016 EDL demonstration lander was selected and will perform measurements of the weather and the atmosphere during a short-lived mission.

- NASA and ESA operating and developmental missions. Fuk Li and Olivier Witasse provided brief updates concerning the currently operating ODY, MER, MEX and MRO missions. Aside from Spirit, these missions are proceeding nominally and are returning valuable scientific data.

MSL is on schedule for a November 2011 launch. MAVEN is on track technically and also with respect to its schedule and budget. (The MAVEN project successfully passed its CDR in July.) After a highly productive six years of operation on Mars, the MER Spirit mission was officially concluded, with the Project having exhausted attempts to communicate with the rover after its long winter ordeal. Meanwhile Opportunity continues to approach the rim of Endeavour Crater.

- ExoMars Trace Gas Orbiter development. Olivier Witasse and Mark Allen provided an overview of this mission, which will conduct orbital science for at least one Martian year, deliver the ESA entry-descent module (EDM), and serve as a telecommunications asset until at least 2022. The orbiter instruments are designed to detect a broad suite of atmospheric trace gases and isotopologues, characterize their spatial and temporal variations, identify interactions with atmospheric aerosols as well as the effects of the atmospheric state, and localize any surface sources of such gases and image surface features possibly related to gas sources and sinks.

MEPAG strongly endorses the proposed joint ESA-NASA missions, which integrate NASA MEP and ESA ExoMars objectives. Combining efforts will pool expertise and also respond effectively to the tight fiscal constraints under which each agency is operating, while continuing to make progress on fundamental scientific goals, consistent with the recent Decadal Survey recommendations. The international community participating in this MEPAG meeting felt that progress was indeed being made, while also recognizing that much remains to be done.

#### **Suggested Actions re: NASA-ESA Joint Missions**

- Complete the MOU and Joint Program Exploration Plan (JPEP), which is critical for stability
- Secure levels of funding that are necessary for the 2016 and 2018 missions
- Mesh different agency cultures
- Complete the early milestones for the 2016 and 2018 missions and thus address the current challenges to coordinate the schedules of ESA and NASA
- Maintain partnership after the first two missions through Mars Sample Return

### **3. Joint Science Working Group and Joint Engineering Working Group, 2018 Mission**

At the time of this MEPAG meeting a Joint Science Working Group (JSWG) was being formed to establish the science objectives, propose engineering requirements to enable these science objectives, draft a reference surface missions scenario, and prepare a report to provide input to a competitive joint instrument Announcement of Opportunity and the associated Payload Information Package. Payload instrument selections would occur in the February 2013 timeframe. The JSWG has now been formed, is co-chaired by Dave Beaty and Gerhard Kminek, and is now proceeding.

The 2018 JEWG will work with the 2018 JSWG to develop cost-effective design concepts to meet the science and engineering requirements while also responding to programmatic constraints and evaluating options for potential international partnerships. Key engineering requirements include developing overall strategies for conducting the surface mission while also enabling landing site access, *in situ* investigations (exobiology, geology, atmospheric science), and sample acquisition and encapsulation. JEWG is considering a range of rover architectures that includes solar vs. RTG power options in combination with configurations for the location (front vs. rear of the rover) of the 2-m drill and Analytical Laboratory Drawer (ALD). The arm and cache will be on the front of the rover. By the end of September, JEWG and JSWG will submit a mission concept that can be assessed for its programmatic feasibility by JMART, JMEB and the two space agencies.

MEPAG endorses the joint study of a single rover mission as a means to attain the ExoMars and Decadal Survey scientific goals while staying within the resource and technical envelopes. MEPAG realizes this will not be easy and applauds the initiation of the 2018 JSWG and JEWG to help explore the trade-space and to preserve the integrated core science objectives of both space agencies.

#### **Suggested Actions re: 2018 JSWG and JEWG**

- Reconcile the science and engineering requirements necessary to achieve the objectives of both ESA and NASA for the 2018 rover mission
- Address the potential option to deliver sample(s) from the 2 m drill to the cache
- Maintain coordination after the first two missions through Mars Sample Return

#### **4. End-to-End International Science Analysis Group (E2E-iSAG) final report**

The E2E-iSAG was chartered to propose reference campaign-level MSR science objectives and priorities and to articulate the implications derived from these objectives. The derived implications include the following: 1) types of samples required/desired, 2) sample acquisition and handling, 3) landing site selection criteria (including specifying some reference landing sites), 4) capabilities of the *in situ* measurements required to support the selection of scientifically outstanding samples, and 5) plans and sample size requirements for the analysis of samples upon their return to Earth. Scott McLennan and Mark Sephton were co-chairs and the membership of the iSAG was well balanced between the North American and European Mars communities.

The SAG reviewed previous MEPAG reports and took into account the latest design concepts. At the MEPAG meeting they reported several key messages and recommendations. MSR should address each of the major goals of Mars exploration: the search for life, understanding the current state and past evolution of the solid planet and its atmosphere and climate, and preparing for human exploration. Eight major community-developed science objectives were identified, the single most important objective being to determine whether the returned materials contain evidence of past life or prebiotic chemistry. Suites of samples must be carefully selected through comprehensive *in situ* scientific observations that also provide critical context for sample analyses that will be conducted back on Earth. Between 30 and 40 samples, with about 14 to 16 g per rock sample, should be returned in order to address the key objectives. Whereas any among several candidate landing sites could satisfy the objectives, the proposed mission might need to tolerate some hazards in the landing ellipse and also be able to traverse beyond the ellipse. The E2E-SAG report specifies the field exploration capabilities and the *in situ* science measurements required to assemble the necessary suites of samples.

A panel of E2E-iSAG members and the audience discussed the proposed MSR program. The group acknowledged that, although demonstrating whether Mars has ever been an “abode of life” will be challenging, sample return is the step that is likely to make the most progress on this as well as a broad range of other science objectives. They discussed options for numbers of samples, the *in situ* measurements, and instrumentation (including imaging the small boreholes created by the arm drill to acquire cached samples). The group also recognized that severe budget constraints must necessarily curb their “appetites” for additional rover capabilities. Methodologies for planetary protection (PP) require more attention; a key objective will be to decrease the amount of mass consumed in the PP sample analysis process. The group also discussed the possibility of even broader international participation in the MSR campaign beyond the current NASA-ESA partnership.

MEPAG endorses the preliminary conclusions and findings of E2E-iSAG and eagerly awaits the final report from the iSAG. No major objections were raised at this meeting regarding the general findings, although the community has been invited to respond with comments and concerns via email as the iSAG prepares its final report. In summary, the E2E prioritized list of scientific goals for sample return, the threshold criteria for landing sites, and the general recommendations regarding sample size/mass/treatment appear to be on the right track, although there will surely be refinements.

### **Suggested Actions re: E2E-iSAG**

More work is needed regarding how and when to decide the nature of the analytical tools in the Sample Receiving Facility. The decision process by which sample material can be safely distributed to other laboratories for more comprehensive scientific analysis must be articulated. This may be the subject of a future SAG.

MEPAG will likely follow up the E2E SAG activity with other SAGs, once the agencies have agreed on the general 2018 joint rover mission design.

## **5. Landing Site Selection – MSL and subsequent missions**

Matt Golombek summarized the highly successful MSL landing site selection workshop that concluded just prior to this MEPAG meeting. Well over 150 participants from the science community and MSL science teams attended the 3-day workshop. Science presentations confirmed that all four of the finalist sites have great scientific potential and should continue to be considered as MSL candidates. The presentations and summary comments are posted on the Marsweb web site (<http://marsweb.nas.nasa.gov/landingsites/>). All four sites were considered safe with respect to EDL and traversability. They were re-evaluated with respect to the richness of the science targets that can be addressed through the combination of mobility, remote sensing and *in situ* analytic capabilities during the nominal mission duration of one Mars year. As a formal input to NASA's site selection process, workshop participants submitted a compilation of the attributes, advantages and shortcomings for each site. (Of course, subsequent to the MEPAG meeting NASA announced Gale Crater as the MSL site.)

Attendees at the MEPAG meeting expressed a wide range of opinions regarding the decision at the MSL site selection workshop not to solicit the attendees' sense of priority amongst the sites. Some commented that an already excellent site selection process could be improved further by soliciting the Mars community's views about site prioritization. Site selection for MSR will impact a larger international community as well as generations of investigators who will examine the returned samples. Accordingly, at its next meeting MEPAG should address the entire site MSR selection process, including the protocols for community advocacy at all stages.

Nicolas Mangold summarized the landing sites workshop in Leiden, Holland in January 2011. Workshop attendees recommended that landing site selection activities for the joint 2018 mission should begin as soon as possible because the currently active orbiter missions (especially MRO and MEX) provide critical information and they might have limited remaining lifetimes. All landing site selection efforts on behalf of JMEP should be conducted in a joint manner between the U.S. and European communities. ESA should develop a forum through which European scientists and engineers can communicate and coordinate their efforts. A data analysis program should be implemented to utilize ESA mission data in preparation for planetary missions.

Matt Golombek and co-authors described plans for a joint site selection program to support the 2018 rover mission. NASA and ESA have moved forward by naming Matt Golombek, John Grant and Nicolas Mangold as co-chairs of this activity. The selection process would start soon and resemble the ones employed for the MER and MSL missions. The organizers will solicit the

international Mars community to propose all scientifically interesting sites that broadly comply with engineering constraints ( $\pm 30$  deg latitude,  $< 0$  km elevation with respect to the MOLA geoid, 25x20 km landing ellipse size, and compliance with hazard constraints [e.g, rocks, slopes] that are similar to those for MSL). The first landing site workshop is currently scheduled for January 2012. About 30 candidate sites would be selected for further imaging by THEMIS, HRSC and MRO. The second landing site workshop in May 2013 would narrow the list of candidates to approximately 12 sites. Based on the work of the E2E-iSAG, seven scientifically compelling reference landing sites have been specified in order to illustrate desirable science attributes that also envelope engineering requirements of the mission in a way that informs the ongoing design studies. (These reference sites are illustrative only and are NOT proposed as actual candidates at this stage.)

### **Suggested Actions re: Landing Site Selection**

- JMEP should move aggressively on a near term program of site selection for post-MSL missions to both inform early engineering decisions and to take advantage of current highly capable, but aging, orbital assets.
- The landing site program for 2018 must truly include international participation, particularly between the North American and European communities.
- In the spirit of adapting an already excellent process to the challenges of MSR, MEPAG offers to assist MEP by including landing site selection (and associated community advocacy) as a topic at its next meeting.

## **6. Planetary Protection**

Catharine Conley, NASA Planetary Protection Officer, and Gerhard Kminek, ESA Planetary Protection Officer, articulated planetary protection (PP) requirements for MSR, as specified by prior international agreements and technical reports. The need for PP is two-fold: to protect Earth and its biosphere from potential extraterrestrial sources of contamination, and to preserve planetary conditions for future biological and organic constituent exploration. The probability that a single unsterilized particle of 0.2 micron in diameter or greater is released into the Earth environment shall be less than  $10^{-6}$ . The subsystems (of one or several missions) that are involved in the acquisition, storage and delivery as well as the analysis of samples used for life detection must be sterilized or cleaned to levels of bioburden reduction, as specified by the nature and sensitivity of the particular life-detection experiments. A method must be implemented to prevent the recontamination of the sterilized subsystems and the contamination of the material to be analyzed. Ongoing studies under contract with ESA and NASA will produce reports related to MSR PP by early 2012.

### **Suggested Actions re: Planetary Protection**

JMEP should follow up on the PP studies currently under contract with ESA and NASA in order to account for their cost and engineering implications.

In summary this was an exciting meeting that benefited from a balanced and energetic participation by both the European and North American Mars communities. The meeting focused on a vibrant program of currently operating spacecraft, on preparations for future missions, including the launches of MSL later this year and of MAVEN in 2013, and on real progress in shaping the form—both scientific and programmatic—of a joint Mars program between NASA and ESA.

Please don't hesitate to contact me if you have any questions.

Sincerely

A handwritten signature in black ink that reads "David J. Des Marais". The signature is written in a cursive, flowing style.

David J. Des Marais

Cc: Doug McCuiston

Jim Green

Fuk Li

Michael Meyer

Rich Zurek

David Beaty

Joyce Pulliam, for forwarding to the MEPAG mailing list