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Dr. James Garvin, Mars Program Scientist
NASA Headquarters
Washington, DC 20546

Dear Jim,

I am hereby reporting to you on the Mars Exploration Program Analysis Group (MEPAG) meeting that was held at JPL on 10-11 September 2003. Approximately 150 members of the Mars science community attended this meeting and participated in the discussions.

The major goals of the meeting were:

- To have significant discussion on the update to the MEPAG "Goals and Objectives" document, and to see if we could reach consensus on each of the four major areas within it.
- To generate discussion and feedback on specific science-related programmatic topics that were raised by NASA HQ.
- To provide a forum in which the science community could raise questions, issues, and concerns.
- To launch a set of analysis teams on science issues pertaining to potential missions beyond MSL.
- To improve representation within MEPAG of the scientists and engineers supported through the MIDP program, and to encourage increased communications between the Mars science community and those who are developing instruments through MIDP.

Major results and points of discussion from the meeting are summarized below. Note that, while the Goals and Objectives document has been worked to the point that we are reaching community consensus, we have not had the same opportunity with regard to the other items of discussion. Thus, while discussion points were raised that in some cases are of substantial concern, and are being passed on to you here, we are not representing them as necessarily being a consensus of the science community.

Updating the "Goals and Objectives" document

Nearly a third of the meeting time was devoted to work in both break-out and plenary sessions on refining and updating the MEPAG description of the scientific goals, investigations, and measurements required for exploration of Mars. All four MEPAG Goal sub-groups (in the Life, Climate, Geology, and Preparation for Humans areas) reached consensus among those present at both the Objective and Investigation level. We discussed at some length how to manage the fourth level of this hierarchy, the required measurements, and the MEPAG Goals Committee

(headed by Jeff Taylor) will be following up on this. We expect to have a next iteration of the complete document ready within a couple of weeks following the meeting, at which time we will give the entire Mars science community an additional opportunity to raise issues or concerns. Once we believe that the document represents a true community consensus, it will be ready to go to the MEPAG Executive Committee for final approval and then transmission to you and formal publication by JPL.

Status of Mars Science Laboratory (MSL)

MEPAG was briefed on the present status of MSL. A number of concerns were raised in response. In particular, the cost estimates for MSL through development, as presented to us by the MSL project, are already greater than our currently understand cost cap for the mission. As costs generally increase rather than decrease throughout the pre-phase-A portion of the mission that we are in, and these costs do not fully include planetary protection issues as yet (see below) there is a risk that the project will require either delays or descopes in order to come in within budget. Either one would be detrimental to both the project and the program. In this context, particular attention should be paid to the potential for descopes that could drive the mission capability below the science floor as described by the MSL Project Science Integration Group (PSIG). This science floor incorporates rover mobility, mission lifetime, number and capability of science instruments, and accessible sampling area and nature of samples that must be obtained and analyzed.

Individuals also raised concerns about the potential ramifications of the planetary protection issues. MSL has the potential (and possibly the desire) to land at places at which water ice might be present today or at which ice or liquid might be present episodically. In the former case, an uncontrolled impact of a nuclear-powered spacecraft might allow long-term subsurface heating that could melt the ice and provide an opportunity for terrestrial organisms carried along on the spacecraft to grow. In the latter case, organisms carried along on the spacecraft might stay dormant until future conditions were more clement, as the obliquity changes, for example, and then grow. Neither of these scenarios has been examined in sufficient detail to be understood thoroughly. Significant open questions are whether MSL will "follow the water", and therefore almost certainly end up in planetary protection category "IVc", and, if it does, whether sterilization will be done in bulk or by subsystem only. The cost and schedule impact connected to this have not been included yet in mission planning, and might place the entire mission at risk. The concerns may be reduced but would not be eliminated by targeting MSL to a low-latitude region away from the ubiquitous high-latitude near-surface ground ice detected by Mars Odyssey—recent analyses suggest the possibility that low-latitude ground ice might be present in low abundances; ice might exist as a transient phase despite its not being stable today, and it is not possible to demonstrate the complete absence of water ice at a given site using remote-sensing techniques prior to landing. MEPAG would be very concerned if these uncertainties forced MSL to shift into an "avoid the water" strategy.

There also is a parallel science concern related to planetary protection. Even a spacecraft that is fully and thoroughly sterilized may contain a large number of now-deceased microbes and other contamination by organic molecules that could jeopardize the scientific integrity of measurements that would search for indigenous organic components. Fully addressing the planetary protection issues might not address the science contamination issues. This is likely to be an important issue for MSL, in that MSL can address questions of astrobiological relevance (such as the presence of organic molecules that may or may not be biological in origin) while not necessarily being a "life-detection" mission in the sense to which planetary protection category "IVb" refers. While each instrument is expected to have its own plan for dealing with the problem, there are spacecraft-level components that will be in the chain of contact for sample acquisition, processing, and distribution and over which the individual instrument P.I. will have no control. We are not aware of this issue having been addressed in a thorough or satisfactory

manner by any recent advisory committee or by the MSL project. After further discussion within the Executive Committee, and with your concurrence, we will convene a rapid-response Science Steering Group to discuss the issue from the perspective of MSL and to make recommendations as to how the project should proceed. The intent is to ask a group of no more than a half-dozen scientists who are working in these specific areas to have discussions at a level of detail that might be appropriate for a small number of telecons, and then to have them report both to the MEPAG Executive Committee and the MSL project on the level of concern that they have for this problem. We will ask them to report back with a two- to five-page report in no more than six weeks, so that we can determine whether a more-substantial effort is required and what form such an effort might take.

MEPAG is concerned by what it heard about MSL implementation and costs at this meeting, and it hopes that its members will be kept abreast of pre-Phase-A and Phase-A planning for the mission. MEPAG offers its assistance should you find that NASA would benefit from further involvement by the science community in defining the MSL mission.

Mars Telecommunications Orbiter (MTO)

The Mars Telecommunications Orbiter has a complex history that involves international collaboration and partnerships, technology demonstrations, and the emplacement of infrastructure for future Mars missions. The potential value of having an MTO in operation as a means of dramatically increasing the data return from future Mars missions is obvious. However, concerns were raised that MTO is to be flown to Mars at substantial cost, but does not have a well-defined scientific purpose and justification. MEPAG has yet to hear an explanation of the critical need of the Mars science program that would be addressed by MTO. While the community understands the "if you built it they will come" approach that appears to be active here, there are no missions currently on the books that will require the MTO in order to achieve their science goals. Concerns were raised that it seems out of character with the history of the Mars program to fly a spacecraft to Mars without a substantial science instrument component. The Mars program could end up with technology demonstrations and infrastructure at the expense of missions that primarily would support the science goals of the program.

MEPAG was not able to provide a detailed analysis of the potential value of a science-payload component for MTO, in part because of our difficulty in understanding the nature of the opportunity. That is, we heard about multiple roles of MTO that included optical communications technology demonstration, data relay, sample orbital-canister tracking, and sample orbital-canister rendezvous; it was not clear which of these were the mission drivers or mission enabling.

That said, we appreciate your and Orlando Figueroa's efforts to put science into MTO. Even a brief discussion leads us to conclude that there is valuable and important science that addresses major objectives of the Mars program that can be done with a small science payload, perhaps within the apparent constraints of available mass, power, and funding. This would be the case for almost any opportunity to place science instruments in orbit around Mars. Potential instruments that were discussed by MEPAG might include an atmospheric imager or sounder aimed at observing the interannual variability of the atmosphere, in-situ or remote-sensing measurements to understand components of the upper atmosphere and escape to space, or radio-science investigations to understand the atmosphere and ionosphere. These by no means exhaust the list of potential instruments, but demonstrate that there are rich possibilities. If development of an MTO proceeds, it would be appropriate to form a Science Definition Team or a MEPAG Science Steering Group in order to solicit widespread community input on the science that can be done and the availability and resource requirements of pertinent instruments, and then to make recommendations as to the science priorities for a potential call for proposals from the science community.

An additional issue of some considerable importance was also raised at the MEPAG meeting. If MTO were to become an element of the Mars infrastructure that future missions come to be dependent upon, then NASA must assure that this infrastructure will be in place when needed. A second MTO then would be required as a back-up to be used in case the first one failed. Anticipating that the cost of two MTO missions is very high and probably unaffordable, we wonder if the objectives of this missions would be more correctly stated as a technology demonstration and a potential means for augmentation of data to be returned from future landed missions.

Radioisotope power generation

The availability of radioisotope power systems that can meet a wide range of power needs is seen as potentially enabling by the science community. We were specifically asked to provide guidance as to the needs within the 0.1-10 Watts (electric) range; the choice of technology to be used for these power systems would depend on where within this range the needs fall. The presentation by George Schmidt of Code S that we received on the ongoing development was the first that most people in the room had heard in detail of the range of possibilities that might be available. The sense of the subsequent discussion was that these would be a valuable resource, but that it was premature to try to recommend needs or an emphasis at specific wattage levels. The scientists were asked to begin thinking about options and needs and to provide specific input either to you or to any member of the MEPAG steering group.

International collaborations and partnerships

Concerns were raised about the status of international collaboration and partnerships. In one instance, it was asserted that NASA's credibility in the area of international partnerships had been severely damaged. The science community is fully behind continuing international partnerships in Mars exploration, and trusts that the national and international space agencies will continue to pursue opportunities for collaboration.

Status of Mars sample return

Numerous members of the Mars science community indicated, once again, that the return to the Earth of samples of martian rocks, soil, and atmosphere at the earliest feasible opportunity would be of tremendous value for making fundamental advances in our understanding of the history of Mars and its potential to have had life or to have it at present. The scientific case for sample return has been made by MEPAG and by other groups numerous times, and nothing in those analyses has changed. To reiterate, we note that, while a suite of carefully selected samples from diverse locations would be of the greatest value, more limited samples as might be obtained from the Groundbreaking Mars Sample Return mission would be of extremely high value as well.

Diversity within the community

In his presentation, Orlando Figueroa raised the issue of community diversity. We pursued this issue with a lengthy discussion regarding the paucity of both junior scientists (within five years of their Ph.D.) and women selected as mission investigators in recent years. As participation in flight missions as a junior investigator, under the mentoring of a more-senior investigator, often is the best way to ensure long-term participation in the flight program, this bottleneck has long-term consequences that may last for more than a generation. We were reassured that this issue had received specific attention on at least one review panel, and that the proposal evaluation had been honest and fair. No single solution to the problem presented itself, either as a short- or a long-term solution. We encourage you to remain aware of the potential for bias in selection, of the value of including individuals with diverse backgrounds and expertise in the Mars program,

and of possible avenues that might arise by which we can better define the root causes of the problem and possible solutions. We suggest, that while considering the diversity in the science community, the same issue with regard to the engineering staffs in the NASA, academic, and contractor communities should be examined.

Science breadth of the Mars program

As in previous discussions by MEPAG, as well as by others, concerns were raised that the Mars exploration program may have become too limited in scientific scope in order to be able to address the wide range of questions toward which it is now aimed. This is not a new problem, but is becoming increasingly frustrating to those portions of the Mars science community who are feeling disenfranchised by the current program. The opportunities that are available within the Scout program have been held up as a way to fill in these science gaps, yet the first selected Scout mission appears to aim primarily at the same scientific questions that are the thrust of the core program. While one possibility is to increase the number of Scout opportunities, at the expense of quantity or capability of missions within the core program, that approach would have its own repercussions (such as loss of overall focus or coherency of the Mars program) and was not seen as a panacea. There was no consensus on what action to take, other than the ongoing recognition that there is a concern here.

Improved connection to MIDP

At this MEPAG meeting, we made a special effort to get the MIDP-II Principal Investigators to attend. I am pleased to report that 13 of the 16 PIs attended and presented posters on their ongoing instrument development. We allocated time during the main session specifically for the attendees to view these posters and to interact with the PIs, and a substantial number of people took advantage of the opportunity. This improved both the community's awareness of what is going on within the MIDP program and the MIDP investigators' participation in the ongoing mission and program planning.

Newly chartered analysis teams

During this meeting, and in response to specific requests from you, we have set in motion the process to launch additional MEPAG analysis teams in support of future missions. These teams will be expected to report back to MEPAG at its next full meeting, which is scheduled for June, 2004, in Colorado. We have asked for volunteers to ensure broad representation of the community, and names are coming in. The new analysis teams to be formed are:

- Astrobiology Field Laboratory (AFL) Science Steering Group
- Deep Drill SSG
- Network Science SSG
- Human Precursor SSG

Please don't hesitate to contact me or any member of the MEPAG Executive Committee if you would like to discuss these or other issues in more detail.

Sincerely,

Bruce M. Jakosky
Chair, MEPAG

cc: Orlando Figueroa, Mars Program Director, NASA HQ
Firouz Naderi, Mars Program Director, JPL
Noel Hinners, MEPAG consultant, University of Colorado
Jack Farmer, past-chair, MEPAG, Arizona State University
Dan McCleese, Mars Chief Scientist, JPL
David Beaty, Mars Science Manager, JPL
Jeff Taylor, chair, MEPAG Goals Committee., University of Hawaii
Jonathan Lunine, Chair, Solar System Exploration Subcommittee, University of Arizona
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