

**National Aeronautics and Space Administration  
Washington, DC**

**NASA ADVISORY COUNCIL**

**PLANETARY SCIENCE SUBCOMMITTEE**

**October 7, 2007**

**Rosen Centre Hotel  
Orlando, Florida**

**MEETING MINUTES**

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**Michael H. New**  
**Executive Secretary**

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**Sean Solomon**  
**Chair**

**PLANETARY SCIENCE SUBCOMMITTEE**

**Rosen Centre Hotel**

**Orlando, Florida**

**October 7, 2007**

**MEETING REPORT**

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## PLANETARY SCIENCE SUBCOMMITTEE MEETING

Rosen Centre  
Orlando, Florida  
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*Sunday, October 7*Welcome and Administrative Matters

Dr. Sean Solomon, Planetary Science Subcommittee (PSS) Chair, called the meeting to order at 8:35 a.m., welcomed members and attendees, and briefly reviewed the agenda (Appendix A). He announced that any findings or recommendations from the PSS that will be discussed at the NASA Advisory Council (NAC) would be formally transmitted through the Science Committee. Before the presentations started, the Subcommittee members introduced themselves (see Appendix C for attendee list). Dr. Frances Bagenal participated in the meeting via telecom.

Planetary Science Division (PSD) Update

Dr. Jim Green, PSD Director, discussed the following topics: administrative aspects, mission status and plans, Research and Analysis (R&A), and strategic planning and assessments. A new Discovery Program Scientist has been selected and announcement will be made shortly. A new NASA Post-Doc, Sarah Noble, will be coming to the Division. (The NASA Post-Doc Program was formerly the NRC Post-Doc Program.) She will be working on the new lunar wedge activities. The Division has had several successful Headquarters-sponsored workshops, including Discovery @15 and Satellites of the Outer Solar System. The next workshop, Planetary Atmospheres, will be held November 6-7, 2007, in Greenbelt MD.

There have been several launches since the last meeting. The Phoenix Mission, launched on August 4, will land next year in the permafrost tundra area of Mars. It will study the history of water and search for habitable zones. Dawn was launched September 27. It will investigate two of the largest protoplanets remaining intact since their formation. In addition, two Missions of Opportunity (MoO's) have been selected: (1) EPOXI—a combination of Extrasolar Planet Observations and Characterization (EPOCh) and Deep Impact eXtended Investigation of Comets (DIXI)—and (2) Stardust NExT. Both of these are moving forward. The first part of EPOXI—EPOCh—is an observing opportunity using Deep Impact's High Resolution Imager, starting in the January time period. The second part—DIXI—will look at a never-before-seen comet, whose trajectory is currently being verified by the science team. The Stardust NExT mission will be using the Stardust spacecraft to perform an extended flyby of Tempel-1 and will provide a good view of the impact region.

The Division is also working on three Phase A's: Gravity Recovery And Interior Laboratory (GRAIL)—a lunar mission, Origins Spectral Interpretation, Resource Identification, and Security (OSIRIS)—an asteroid mission, and Vesper—a Venus mission. Down-selection should be announced by December 2007. Dr. Green noted that there has been an increasing level of work in the AO process. He invited members to express their opinions on how the process could be less onerous. NASA is on time for the Mars Scout selections—Mars Atmosphere and Volatile Evolution (MAVEN) and The Great Escape (TGE) in January 2008. The Division is moving forward on the MoO's selected at the same time as these missions.

Dr. Green provided an update on mission studies. The Outer Planets Flagship mission studies have been submitted and site visits should be completed by November. The Division has initiated a couple of "billion-dollar box" studies—Comet Surface Sample Return and Venus In Situ Explorer. Relative to Flagships, the current Inner Solar System Flagship is MSL; the next mission after that will be an outer solar system Flagship mission, and the following inner solar system Flagship could be focused on Venus. The National Academy study on the principles for determination of the mission set in the New Frontiers call is continuing. The next meeting is in December. The Academy is also considering Mars in its study. The primary question is whether Mars should be part of New Frontiers.

Dr. Green provided an update on Mars. *Opportunity* landed in Eagle crater and made its way to Victoria crater. The Mars Rovers were in a global dust storm June through September, but they were able to survive and are now back in operation. *Opportunity* has been approved to descend into Victoria crater now that the

dust storm has subsided. Dr. Green discussed MSL replanning. The Mars Exploration Program's (MEP) budget is a little more than 40% of the entire Division budget. In January, Phoenix needed another \$25M. In May, the MEP started focusing on sample return, and in June, MSL sample caching was added. MSL was rebaselined in September to recoup about \$62M. The new Rover extensions were funded through FY 08 and funds have been programmed for FY09. Dr. Green reviewed the yearly history of MSL, starting with MSL confirmation in August 2006. At that time, the Program added \$32M to increase cost reserves to 35%. This was approved at both the Directorate and Agency management councils. In late 2006 and early 2007, several aspects were running into trouble and a descope of \$20M was done to control cost growth. It was noted that MSL is one of the most difficult Flagship missions in the Division. In June 2007, the MSL program estimated it would need another \$75M, and the Division went through the process to mitigate the cost growth. The program office, assisted by the Headquarters Chief Engineer, proposed a solution strategy. An Independent Science Team was created to define the floor for MSL. This team was put together quickly and a science floor (elements that must be retained) was established for the science instruments. The science floor is determined by looking at the basic science goals and minimum success criteria. A capacity of about \$62M was created for MSL, which included about \$26M in descopes and \$36M new funds from Mars Program reserves.

Dr. Green emphasized that the previous strategy of "robbing" R&A to fund flight programs is now off the table. Missions that are in trouble must use their own reserves. Overruns above the 15% baseline (the "Nunn-McCurdy" level) must be reported to Congress, and this level of overrun raises the possibility of program cancellation. The present MSL overrun is about 3.3%, far from this threshold. Dr. Green stated that NASA is taking a much harder look at overruns. In response to a question, he indicated that MSL still has reserves, which must be held for future potential problems. He added that this process preserves other program assets, such as the 2011 Scout opportunity. The push is to make compromises, rather than robbing funds from other programs. From now on, the Division will put more into the reserve area for these larger missions. Another issue raised was unrealistic costing profiles. Dr. Green agreed that both of these are key principles. There are also some problems with managing reserves. Projects may expect to use end of year reserve money to retire risk. There needs to be an interaction with Headquarters that preserves the reserve posture and rolls the money forward.

Dr. Green reviewed the details of the MSL descopes. The Program/Project Office put potential descopes in three categories—those that it recommended; those that it recommended with programmatic implications; and those that were not recommended due to high science or technical risk. Almost all of the descopes were from the first category; none were from the third. The Subcommittee discussed ChemCam, which was in the second category (it will receive no additional funds beyond FY07), and the following question: Do the instruments really drive cost overruns? Dr. Green indicated that in general, the answer is yes. He noted that the cost baseline of a mission, including the level of reserves, is set at the Agency system level Preliminary Design Review (PDR). The Project Manager is responsible for managing the instruments beyond this point. The Project Manager must balance schedule, instrument mass, and cost. Dr. New indicated that the Discovery Program is conducting a study that is looking at where the "seeds" of problems are planted in the overall process. It was noted that the cost of an instrument includes the cost of instrument requirements on the spacecraft side. It was also noted that France is providing some elements of ChemCam.

Sample return is critical to solar system exploration, and MSR remains a high priority mission. The MEP budget cuts pushed MSR well beyond 2020; however, the Division developed a new strategy to advance MSR to 2020. NASA is making plans to place a sample cache on MSL. International interest in a 2020 mission is expanding. MSR needs to be an international effort. ESA is considering adding a cache to the 2013 ExoMars mission. ESA's Aurora Program contains MSR in the 2018-2020 time frame, which aligns with the US MEP timing. In September, there was a kick-off meeting of the International Mars Architecture for Return of Samples. MSL sample cache will be a multi-center partnership between JPL and ARC and will be funded out of Science Mission Directorate (SMD) reserves. However, there are some constraints on mass and cost, and MSL technical needs and project schedule have priority. Dr. Green described the MSL sample cache configuration. The project is considering at least 5 samples with a goal of 10. In response to a question, he indicated that there are constraints with this MSL cache system. However, a number of options for the cache have been designed. This design will be a step along the way

in the collection of the next set of samples. In response to a question from Dr. Taylor, Dr. Green indicated that the Division does have plans for the moon, but those plans are wrapped up in the budget submission to OMB and cannot be discussed until the President presents that budget to Congress in February 2008. MSL sample caching will be a great tool for training scientists in sample collections. The Program is examining the following question: Given the constraints and the capability, what things can be expected? CAPTEM will be having a workshop at the end of April to look at what sorts of analyses can be done and what those analyses will tell us.

Dr. Green discussed R&A changes. For FY 08, the Division has increased R&A by 20.4%. There will also be an enhanced budget for Astrobiology. The Division took a hard look at the funding being spent by the Centers in technologies beyond 10 years away. This is where most of the funds for MSL have come from. The Division will be having a discussion on Monday on what new technologies must have continued support. There are new opportunities in ROSES in 2007. The Request for Information (RFI) on the use of the new MoO Announcement of Opportunity (AO) closed on September 21. The RFI on International Space Station (ISS) attached payloads closes October 12. The Discovery and Mars Scout Mission Concepts closes November 30. The number of years a proposal can cover has been increased to 4 or 5 years. This pattern will continue in ROSES 2008. The DDAP will fold into a new Planetary Data Analysis Program (PDAP), including any Planetary Data System (PDS) data plus data restoration. Other opportunities will be announced at NASA Night.

NASA is making plans to release a MoO call in 2008. Information on active partnering with other organizations was requested from the community. The Division received over 100 responses, with about 25 for planetary. A Spring 2008 release is expected. The New Mission Concepts Study call will open up new vistas in planetary science. This call is for proposals for 6-month studies that stay within the cost cap of the program, i.e., Discovery, and assume Stirling Radioisotope Power System (RPS) units as government furnished equipment (GFE). Non-proprietary study results will be posted on the Web. This call presents an opportunity to shape the future of the Program through this method. There is a \$22M lunar wedge in 2008. The Division is investing in open competitive elements, including MoOs and LASER call proposals. About one third of the LASER call proposals are for basic lunar research; about a third are for applied, and about a third are both. LASER is co-funded by the Exploration Systems Mission Directorate (ESMD). With respect to the evaluation panels, the Division is working the conflict of interest issue. After the first year, operations of the Lunar Reconnaissance Orbiter (LRO) will transfer to the SMD and will be used for science. Scientists are working with the LRO team to define the science requirements. Several studies will be initiated, which could include lunar sample return.

Dr. Green discussed the next strategic planning cycle. The Government Performance and Results Act (GPRA) of 1993 requires that each Agency generate a strategic plan every three years. NASA's Strategic Plan is due in 2009. The SMD approach has been to follow the Agency Plan timeline within a year. Dr. Green showed a notional schedule and the development flow for the new SMD Science Plan. In preparation for the 2009 edition of the NASA Science Plan, the Division needs to update its Roadmap. The Roadmap Team will be chosen through a two-part process: recommendations from various groups, and a solicitation for self-nominees. The Director of PSD will appoint members from these lists. The Team is expected to be about 10-15 members. The PSS will be asked to "red team" the Roadmap and recommend approval to the Science Committee. Dr. Green presented the question: Can we streamline the process? It takes 30 months to develop the Science Plan. For this Plan, planetary, lunar, and Mars will be integrated into one priority queue. The last PSD Roadmap took two years, and the Division only has one year this time. Dr. Green invited Subcommittee input on an approach to meet the timeline. Dr. Solomon suggested using a "delta" approach from the last PSD roadmap rather than starting from a clean sheet. Dr. New invited the Subcommittee to think about whether including specific mission concepts is really necessary, or whether discussing venues would be more flexible and appropriate. Dr. Luhmann noted that a lot of the community consults the roadmap and it helps "channel" responses to NASA. With respect to the roadmapping process and the amount of effort going into it, she encouraged the Division to be sensitive to the time investment from the community. In response to a question, Dr. Green indicated that the next Decadal Survey will be too late to be used in this process.

Small solar system bodies are a hot topic, and there have been a lot of discussions in joint meetings with JAXA (the Japanese space agency). The first meeting of the International Primitive Body Exploration Working Group (IPEWG) will be held January 14-16, 2008, in Japan. PSD needs community input for NASA's delegation to the IPEWG. The NEO Spaceguard Survey and future detection and mitigation will be discussed at the Congressional hearing on October 11. Dr. Green reviewed some topics that will be discussed in preparation for the IPEWG meeting.

#### Discussion

Dr. Luhmann asked why planetary has not been in the dialogue on the revisiting of the Triana/DSCVR mission. There might be some room for broad, interdisciplinary missions, and planetary may wish to participate in the dialogue. Dr. Green indicated that he would look into this.

Dr. Solomon opened the floor to any other relevant topics. Dr. Green indicated that Dr. Stern would be making an announcement on several positive things at NASA Night on Tuesday, October 9.

The Subcommittee discussed the new PI requirements. Dr. Dickerson noted that the Subcommittee has asked for better granularity on these requirements and what is used by the Division to come to decisions on suitable participants for proposals for AO missions. Dr. Solomon indicated that the Subcommittee was concerned about the new requirements for Discovery, Scout, and New Frontiers. There are fewer opportunities to take advantage of suborbital opportunities in the planetary program. The higher bar for mission PIs may reduce emerging ideas for planetary missions. The Subcommittee would like more feedback on the quantitative studies that went into the decision. Dr. Green indicated that this is an excellent topic for Dr. Stern, and suggested that the Subcommittee raise this view with him. Dr. Neal added that the result of the new requirement could be a figurehead PI who satisfied the PI requirements, or very few responses to AOs. Dr. Luhmann observed that experience is key to the success of the PI-led AO mission. People who are motivated to become PIs to AO class missions take it upon themselves to develop the skills needed and get their career on the right track to lead these types of missions. The PI must have the insight to know whether or not the Project Manager is doing a good job. People tend to underestimate what NASA demands of PIs on PI-led missions. Dr. New noted that as currently implemented, the PI requirement is a compliance check, not an evaluation criterion. The pre-screening helps a proposing organization decide whether or not to invest money into development of a proposal. The current implementation assumes that there is a single prime mover. Dr. Weaver added that the training paths that have been identified in the policy may not be as applicable to planetary missions. Even within the planetary science community, there are differences, *e.g.*, experience on sample return missions. Other Subcommittee members were not convinced that this new policy is a viable approach and serves the interests of the community. Dr. Hamilton noted that mission teams tend to have the same composition and are difficult to break into. The questions that need to be addressed are: Are the on-ramps working for everybody or all fields? If they are not, how can that be fixed? How can there be apprenticeships on missions? Dr. Solomon noted that being a PI on a major project is a big job, and one needs to be passionate about it. The old system didn't work that badly. The PI's skill and experience in management and leading a team has always been a part of the AO review. It was noted that the PI-led mission study that was led by NRC was a result of NASA's experience with PI-led missions, *i.e.*, there was a perception that they were out of control. Dr. Neal noted that the Subcommittee's request for data regarding the success/failure of PI-led missions vs. non PI-led missions was never addressed.

Dr. Green felt that the issues raised by the Subcommittee were good questions that should be brought to Dr. Stern's attention.

#### **Analysis Group Reports:**

##### Venus Exploration Analysis Group (VExAG)

Dr. Janet Luhmann, Co-Chair of the VExAG group, reported on recent activities. The next meeting will be November 4-5 in Greenbelt MD, in conjunction with the NASA Workshop on Planetary Atmospheres. The main activity has been completing the whitepaper (the group's first major report) outlining key science questions and goals for Venus exploration. Dr. Luhmann invited input on the paper. The group has been helping organize the Venus Flagship Mission Science and Technology Definition Team (STDT) kickoff.

There has been an effort to engage the Earth science community in a comparative planetology dialog. The group is supporting activities in the US for Venus Express (a ESA mission). VExAG has also been providing support to the NRC NOSSE (New Opportunities in Solar System Exploration: An Evaluation of the New Frontiers Announcement of Opportunity) committee.

Dr. Luhmann reviewed the outstanding questions pertaining to Venus exploration, which appear in the white paper report. VExAG's analysis translated these questions into three major goals for Venus Exploration. The challenge of the group and all mission planning to Venus has been the extreme environment in order to get closer to the surface. In 2005/2006, the Solar System Roadmap Team considered both the Venus in Situ Explorer (VISE) and Venus Surface Sample Return (VSSR). It also proposed a Venus Mobile Explorer as the next logical step after VISE and before a sample return mission. VExAG has now played a key role in initiating a STDT study for the Flagship mission. Many of the future Venus missions have different concepts for moving around Venus, both in the atmosphere and over the surface. The core of the report includes technology investment findings for achieving extended operation in the Venus environment. The proposed action is that NASA should initiate a program to develop technologies for operation in Venus' extreme environment. A number of aspects were highlighted, e.g., passive and active thermal-control technologies for extending operations, high temperature electronics, and mobility systems. Hopefully, there will be investment in the next year or so towards these technologies. The New Frontiers finding was that VISE should be included in the New Frontiers AO in FY08. The proposed actions are to leave VISE in the New Frontiers list, retain the scientific goals for the mission, and consider implementing a technology validation element for VISE that would permit demonstration of technologies needed for a long-duration mobile mission. It was noted that most Venus missions have significant mass margin.

Regarding the Venus Flagship mission, the proposed action is for NASA to initiate a study of a Venus Flagship mission. The study should not be delayed because the technology path necessitates start at the earliest opportunity.

Dr. Luhmann reviewed the recent developments in the Venus Flagship Architectures Mission Study. This study will start soon and come to closure in FY08. Objectives include development of options for an inner planet Flagship mission in the 2020-2025 time frame, definition of the enabling technologies and development of a technology plan, identification of the technology validation experiments that could be conducted on New Frontiers or Discovery missions, and definition of a scientific and technological pathway to a VSSR mission. The study will be conducted under the guidance of a STDT. NASA plans to issue an invitation for community participation in the STDT in late October. VExAG members supported the planning of the Venus Flagships Architectures Mission Study and participated in two workshops this past summer. The technology emphasis is a unique feature of this study.

The VExAG will have a new chair shortly (the candidate is currently going through the NAC confirmation process). The European Venus Explorer (EVE) is a proposed in-situ mission to Venus. It has made the first competitive cut. The Russians will provide launch and a lander. ESA will be flying an orbiter and a balloon, with potential contributions from France and Russia. NASA /JPL has been participating in the balloon technology studies. There is a possibility of a mid-cloud balloon by JAXA. Earliest launch is 2016. There will be a downselect of two missions within a year. EVE needs to be factored into the NASA Venus discussions.

Dr. Luhmann briefly showed the agenda for the next VExAG meeting in Greenbelt, MD. There will be a special session on Venus-Earth climate connections. Dr. Solomon thanked Dr. Luhmann for co-chairing the VExAG and participating actively in the PSS.

#### Field Exploration and Analysis Team (FEAT)

Dr. Neal presented the FEAT update for Dr. Snoke, who could not attend the PSS meeting. The membership is 50+ and growing, including four Apollo trainers and two astronauts. Developing field expertise is a cumulative process, and needs to start early. FEAT is forging links between science, operations, and astronaut communities, which will allow time to develop collective experiences for productive and efficient interactions. Direct access to details of Apollo geologic training will soon be lost,

and the wisdom of the Apollo Program veterans must be captured. In addition, young field geoscientists must be recruited and trained. FEAT will also assist in the development of a field program. FEAT has developed a white paper (an evolving document) that outlines concepts for lunar field work, rationale, equipment and training needs. The importance of geological field training for the return to the moon was recognized at the NAC Tempe Workshop. There was a FEAT session at the Lunar Exploration Analysis Group (LEAG) annual meeting last week.

Dr. Neal reviewed the findings from the Tempe workshop. There will be another FEAT meeting at the Geological Society of America Annual meeting in Denver on October 29. Dr. Dickerson added that the next astronaut candidate class will be selected in May 2009, and planetary experience will be included in the announcement.

Lunar Exploration Analysis Group (LEAG)

Dr. Neal reported on the LEAG activities, including the annual meeting that was held last week, an update on IMP-SAT, and future plans. The annual meeting was held in Houston, and the topic was “Enabling Exploration: the Lunar Outpost and Beyond.” The goal was to define pathways to offset cost and risk of the next lunar exploration. Dr. Neal reviewed the meeting outline. The first day consisted of briefings and community updates; the second day included talks on international partnerships, In Situ Resource Utilization (ISRU) and outpost sustainment demonstrations; the third day was on the role of robotic missions; day four focused on sample return and Lunar Exploration and the role of technology; and day five was on site selection and the lunar outpost. The poster sessions (on two of the evenings) were well attended. Each session had a number of questions that speakers were asked to address. The overarching question was: How can risk/cost be reduced through cooperations and partnerships in technological developments and demonstrations? The sessions also encouraged Mars feed-forward discussions in briefings, sample return, ISRU, FEAT, and outpost site selection. The meeting was about 60% presentations and 40% discussions.

Some concerns raised were: What is the Vision? Why are we going back to the Moon? The Vision appeared blurred. Taking the current vision policy statement, the goal is: “Moon, Mars and Beyond—learning to live off the land with feed forward to Mars.” This wasn’t clear in the LAT-2 (Lunar Architecture Team 2) report. International partnerships are of great value, and NASA has made a good start in that direction. An ISRU demonstration mission is critical for outpost sustainability and Mars feed-forward. ISRU can be enabling without being in the critical path. They can be used to mitigate  $\Delta V$  issues and facilitate feed-forward technologies. All of the LEAG presentations (except LAT-2) will be available on the LEAG website by the end of the month. What came out of the Robotic Missions session was support for an aggressive lunar science campaign to the lunar surface. Some of the robotic missions could be enabled by commercial leveraging with NASA and could lead to near-term technology demonstrations. LEAG, through the NAC, could define a lunar science campaign. Commercial elements want an “infrastructure” from NASA that they could then maintain and use. The meeting consensus was that commerce needs to be willing to take more risk rather than have NASA take all the risk.

There were some ideas on how to reduce risk and cost with technology development: precision landing; sample containment/preservation; coring and manipulation; and on-surface curation. Contamination mitigation was discussed, but it was in terms of maintaining the pristine nature of the samples, rather than planetary contamination. There were some important comments related to technology in the field: the “KISS” (keep it simple) philosophy; relieving astronauts of detailed sample documentation by employing new technologies; using potential analytical tools in the field during training; the importance of the work bench and rock splitter near the habitat for sample high grading; and the use of telepresence technology in field training. The site selection process needs to be open, build on history, and be inclusive of all stakeholders. Trust (and communication) needs to be built up in the international-commercial-NASA partnerships. From the commercial perspective, the site needs to be resource/energy rich, provide entertainment/public engagement value, and be accessible to areas of scientific interest. There will be an on-line report with presentations on the LEAG website at the end of the month.

The LEAG was charged to map the 16 lunar science objectives to an implementation plan. The charge was expanded to include potential commercial and/or international partnerships and highlight any ISRU

linkages. LEAG will center on the five themes from the Tempe workshop. Dr. Neal described how the objectives and the plan would be developed.

LEAG also provided input to the NRC NOSSE Committee. LEAG is starting to plan LEAG 2008 to coincide with the LRO launch (October 27, 2008). The group will work on a “Lunar Goals Document” that would crystallize the goals and objectives and put things in context. Dr. Green liked this idea and gave Dr. Neal direction to move ahead with the activity. Dr. Neal noted that some of the demonstrations are important to a robotic campaign plan. There may be some innovative ways to do things—funding, partnerships, etc. This message needs to get out to the community. In response to a question, Dr. Neal indicated that the input to the NRC NOSSE was submitted under a series of questions. The South Pole Aiken is important, but should not be the only one.

Mars Exploration Planning and Analysis Group (MEPAG)

Dr. Vicky Hamilton reported on MEPAG for Dr. Jack Mustard, who could not attend the meeting. A series of major events have occurred since the last PSS meeting. The second Mars Science Orbiter Science Analysis Group (MSO SAG-2) submitted a report outlining three possible scenarios for a 2013 MSO. There was a MEPAG meeting at the 7<sup>th</sup> International Mars Conference. There has been a response to a possible Mars Sample Return (MSR) lander launch by 2020: formation of the MSL Cache Science Analysis Group and the Next Decade MSR Science Analysis Group. There has also been a response to NOSSE regarding the opening of New Frontiers to Mars missions.

With respect to the MSO SAG-2 report, Plan A (atmospheric studies) was selected for consideration by a SDT. This selection was announced at the 7<sup>th</sup> Mars Conference. Dr. Stern indicated that MSO is under consideration in light of the MSR directions. The MEPAG discussed Dr. Stern’s comments in its evening session. There was enthusiasm for a MSR commitment. Concerns focused on the impact of the cache addition to MSL, what must be done for MSR to return samples, and what the program architecture would be to sustain the financial commitment to MSR while addressing the broader Mars science program. A lot of this was addressed in subsequent events. The MSL Cache SAG was formed with the NASA Astrobiology Institute to assess the MSL cache capability to address science questions. The SAG report should be available around the end of October. The Next Decade MSR SAG was formed with two objectives: analyze questions related to the kinds of samples; and analyze the primary non-sample objectives that can be achieved in a set of missions that leads to MSR. There is overlap in membership between the two SAGs and there is CAPTEM representation on them as well.

The draft Goals Document has gone out and comments are being collected toward a revised draft on December 3. The document should be released next spring. Dr. Hamilton reviewed the response to the NOSSE request. To the extent that it represents an additional opportunity, opening New Frontiers to Mars missions would advance Mars science. However, if the New Frontiers opportunity is meant to offset the deletion of strategic missions from MEP, an opening of New Frontiers to Mars missions would result in a loss overall and would slow the pace of Mars exploration. MEPAG has not prioritized the list of strategic possible missions for Mars although if it is decided that a New Frontiers AO should be more directed (than a wide-open competition), a Mars Network mission would be a suitable candidate.

Following the 7<sup>th</sup> Mars conference, Dr. Stern invited MEPAG to send a delegation of scientists to meet with him and to exchange views. The discussion focused on Mars as a program, MSR and MSL cache, strategic missions and whether or not MSO should be the next one, and the impact of MSL descopes on science and international relations. Coming away from the meeting, the impressions and actions were: MSR should be considered the first sample return from Mars; MEPAG will consider candidates for a strategic mission other than MSR, including MSO; continuing concerns about impacts on international collaborations; and the need for some discussion as to how MEPAG can continue to provide an independent perspective on the process as MEP evolves.

Dr. Hamilton discussed the science impacts of the descopes to the MSL payload: diminished imaging capability; landing site less well characterized; effects of alternation rinds; loss of the only remote geochemical capability on MSL; loss of a capability to measure atmospheric isotopes; and added risk for completion of two essential instruments.

By the end of 2007, the following things will converge: selection of the 2011 Scout mission; revision of the MEPAG Goals Document; report of the HEM-SAG (Human Exploration of Mars), report from MSO SDT, and preliminary findings from MSR-ND and MSL Cache planning teams sponsored by MEPAG. There will be a major MEPAG meeting in February in Monrovia, CA. In response to a question, Dr. Hamilton indicated that the Mars Scout would be complementary (not redundant) to MSO in terms of capability. There is a major conference on solar wind in January and this might be an interesting complement to the Scout selection.

Outer Planets Analysis Group (OPAG)

Via telecom, Dr. Fran Bagenal provided a status update on OPAG, noting that there has not been an OPAG meeting since the last PSS meeting. She showed the science objectives for Europa. The goal is to explore Europa and investigate its habitability. Titan is an exotic, Earth-like world with a dynamic and evolving atmosphere and active geology. It provides clues to the origin of life on Earth. For Titan, an orbiter, an aerobot, and a lander have been proposed. One of the main objectives of the review is to look at technical feasibility on cost. Another Outer Planets target is Enceladus. A team is looking at concepts and scope for a Flagship mission. The last of the four potential Outer Planets missions is a Jupiter System Orbiter. Dr. Bagenal reviewed the Flagship studies schedule.

Dr. Bagenal discussed technology development for future missions. There has been progress in RPS development; however, OPAG is concerned that overall technology development for future missions is progressing too slowly. OPAG suggested that the PSD review its current technology investments. There will be an OPAG meeting in November where there will be a report on the four Flagship Studies, discussions on technology development for the outer solar system, a comet sample return study, and strategic planning. Dr. Green noted that the downselect on the four Flagship studies will be in the December time frame.

Curation and Planning Team for Extraterrestrial Materials (CAPTEM)

Dr. Chip Shearer gave a report on CAPTEM. He briefly reviewed CAPTEM's functions, structure, and allocation approaches.

CAPTEM plays an important role in the allocation of NASA collected planetary materials. It provides analysis and guidance for NASA sample curation and sponsors a number of workshops. A number of CAPTEM subcommittees are closely tied to analysis of sample suites. The next CAPTEM meeting will be this Thursday and Friday. At this meeting, the only allocation numbers are from the Lunar Sample Subcommittee, which has 10 requests. Four of these requests are for ISRU. In response to a question regarding Mars, Dr. Shearer noted that at this time, the CAPTEM has not been considering Mars samples. However, there will be an organization meeting in the very near future at which Mars will be added as a CAPTEM subcommittee. Most of the Mars samples that are currently curated are from meteorites collected in Antarctica by the NSF-sponsored ANSMET program, and CAPTEM has nothing to do with those. There is a separate group that allocates all meteorites from that collection, including Mars samples. Private collectors also have Martian meteorite samples. It would be useful to have a liaison person for these groups.

The final version of the CAPTEM analysis of the sample return mass needed to accomplish science during lunar surface activities has been forwarded to the NAC. It is based on recommendations from the NAC-sponsored Tempe workshop on Lunar Science. Dr. Shearer presented a couple of questions. What is the status of the response to this analysis? What is NASA's response to the other PSS findings from the Tempe meeting? It was noted that there should be a response at the NAC October meeting.

CAPTEM is looking at new handling and allocation approaches for "new" Apollo samples — these are Apollo 17 samples that were specially collected and never studied.. With regard to the moon, the LAT briefing on lunar outpost site selection listed science as having no importance in the process. However, based on LAT estimates, science was going to be the dominant activity of outpost astronauts. Science considerations should be part of the site selection process. CAPTEM is currently developing a plan for the preliminary examination of Stardust Interstellar dust samples.

With regard to Mars Sample return, CAPTEM has performed analysis of the utilization of Constellation architecture for Mars sample return analysis. CAPTEM members are serving on the MEPAG science analysis groups tied to MSR. CAPTEM has provided sample-relevant initial information to MSL caching design. It has organized a study group to analyze buying down risk and increasing the competitiveness of sample return missions. The group is identifying components fundamental to carrying out sample return missions, defining how potential pathways will feed forward, and analyzing what investments would reduce risk and cost in sample return. The first draft of the white paper was completed at the end of September and is currently in review. CAPTEM is not presently studying the capture of atmospheric gases, but it will be studying technologies for doing that.

#### Discussion with the Associate Administrator

Dr. Alan Stern provided his general impressions over the past six months. In response to some comments regarding “fences” between parts of the NASA budget (*e.g.*, human space flight and robotic science), he noted that he has never been “micromanaged” on the budgetary fences although there is some talk of Congress doing this in the next budget. There were controls put in place in response to community concerns, but this is not an issue at this time. Dr. Shearer noted the problem with the dearth of scientists with sample return experience. The first steps toward sample return will be launching in 2009, MSL. What is the potential to incorporate some people into the Mars Sample cache to give them some experience? Dr. Stern gave an example of PI’s who would be qualified for a sample return mission. The Directorate is working to provide on-ramps for qualifying experience. Dr. Green added that there are things in the program that have withered, and the Division is going to try to revive those to provide more experience. Dr. Stern noted that currently, they are building a ladder based on complexity of experience. For smaller missions, a candidate needs to have one of a number of different experiences. The qualifying experience could include experience on an instrument. He advised the community to look to the AO’s to find these tracks. A suggestion was made to post these types of opportunities on the website.

Regarding MSL’s international collaborations, Dr. Stern agreed that these are very important and he has been directly working on these connections over the past six months. However, international collaboration is not an excuse for the 60%-70% overruns. Dr. Shearer noted that a real advantage of caching samples on MSL is collection over a diverse terrain and being able to document the on-ground context to which those samples are tied. Rather than eliminating some of the characterization techniques from MSL, are there pathways for additional funds outside of NASA? Dr. Stern noted that DOE is looking at ways to recover some savings for ChemCam. NASA is currently keeping the Phase E funds for ChemCam intact with the expectation that the instrument will be delivered and integrated into the rover.

Dr. Solomon noted that one of the principal reasons for the new PI requirements is to force more attention to cost containment. In the past, cost containment was not as important as getting the job done, and there was an expectation that additional funds could be obtained. In terms of PI-led missions, we should focus on the appropriate driver for the cost growth. Dr. Stern indicated that when he came on the job, he wanted to scale back on cost overruns. Over the past 5 years, about \$5.4 billion has been directed to cost overruns. The PI experience requirements are not a “magic bullet” to solving cost problems. However, it is difficult to argue to Congress why NASA should let people with zero experience in spaceflight lead spaceflight missions. We must insist that PI’s on PI-led missions have spaceflight experience. Over time, people will adjust. The difficulty is in the transition, but there are many ways to get around the transition problem. The overrun problem is throughout the whole system—NASA Headquarters, the Centers, the contractors, the science community. Realistic costing is now a very important factor. NASA is starting to use another tool to forestall overruns—descope at selection.

With respect to the future of R&A and streamlining the process, Dr. Stern noted that the people that NASA has recruited have been in the science community and understand the problem. His organization is trying to clean this up. Already, there is some innovative thinking going on. People who are making discoveries in the R&A program should be doing science, not spending their time writing proposals. SMD is trying to get the win rates in every program the same — one in three.

With respect to reserves, there are a variety of ways that a program or project manager watches reserves, but there has been an expectation in past years that NASA Headquarters will bail out the project if the reserves aren't sufficient to cover the overruns. It would be helpful if the PSS played a role in emphasizing the importance of cost control and helping the community to get on board with cost consciousness. Dr. Neal indicated that it would be very useful to have the overrun statistics to show to the community. This information would help to get the community behind the rationale. Dr. Stern agreed and asked Dr. Green to see that the information gets to the Subcommittee. The next round of Decadal surveys is Astrophysics. Last time, there were no independent cost estimates, and the costs of missions were wildly optimistic. In the next round, astronomers will have to get independent cost estimates garranged by the Science Support Office at Langley, the same organization that organizes the TMC reviews of mission proposals. In addition, every mission will come in with a maximum price the astronomy and astrophysics community willing to pay—a "tripwire."

The first word in the Directorate is "science" not "mission," and R&A is off the table to fix overruns. Science has to come first. Technology tends to get away from what people really need, and it can easily become a "sandbox." With respect to long lead technology development, SMD will require missions to develop the technologies that they need, so that the people who are buying the technology are the ones needing it. If SMD gets an Outer Planet Flagship and it requires new technology, then that mission will have to bring that technology along. In full cost accounting, the cost of technology is part of the mission.

With respect to launch vehicles, the Delta II workhorse is going away. NASA must buy Atlas V's and Delta IV's for missions even though they don't require that capacity. There are very small-end rockets, e.g., Pegasus, but there is nothing in the middle. New vehicles like Falcon are coming along, but it will take a few years to before there is a reliable mid-size vehicle. There is no perfect solution. There is a study that is looking at what missions could be paired together for launch. It is harder to do in planetary, but that doesn't rule out all the options.

MSL passed its Critical Design Review (CDR) and is the highest priority. The purpose of early sample caching is to make sample return a concrete reality as soon as possible. Also, the total sampling will be better than what is just in the basket for MSL. Cache sampling can enable a better focus on tools for MSL and subsequent sample missions.

Dr. Stern emphasized that one of his four top objectives is to make space exploration succeed. Lunar science does not depend upon an astrobiological aspect. There is a lot of lunar science that can be done. SMD has people that have been tasked to work with ESMD to ensure that the two organizations go forward together and not as "stovepipes."

In response to a comment, he noted that the National Academy has done a review of areas where the International Trafficking in Arms Regulation (ITAR) has hampered science.

It would be helpful for the PSS to have a discussion on an Outer Planets Flagship mission. These missions are very hard to get, and we must ensure that the four targets get narrowed to one that is collectively supported by the community. If there are factions, the number will go to zero. Dr. Solomon indicated that the PSS would work with the community on this issue.

Dr. Solomon asked each of the Chairs of the analysis groups to write a short paragraph capturing the most important findings and the most important proposed actions from their groups. From this, he will prepare a briefing to the Science Committee at the NAC.

#### Discussion of Formation of Small Bodies Analysis Group (SBAG)

Dr. Hal Weaver discussed the proposed formation of a SBAG. NASA currently lacks an assessment group that adequately represents the Small Bodies community. OPAG has tried valiantly to include small bodies but for a number of reasons, this has not been totally successful. OPAG focuses primarily on Flagship missions to giant planets. The group includes comets and TNOs, but asteroids and meteorites were never in the charter. Expanding the scope of OPAG is not the best answer. Dr. Weaver showed the members on the proposed SBAG "steering committee." This group discussed what would be included in the SBAG charter.

SBAG would include all small bodies that orbit about the sun—comets, asteroids, trojans, centaurs, and TNOs—as well as meteorites and “orphans,” such as Phobos and Deimos, that fall through the cracks. A Small Bodies Workshop in January has been proposed. This workshop would develop an organizational structure, an outline for a White Paper describing both the near-term and future strategy for Small Body Exploration, and a SBAG web site. The Planetary Systems Science Management Operations Working Group (PSSMOWG), which had Near-Earth Objects (NEOs) in its portfolio has become disconnected from the PSS and needs to get reconnected to the Subcommittee. Dr. Green noted that the new advisory structure has changed the type of assessment advice that NASA gets. The decision to start a new analysis group would need to go through the approval process, i.e., through the NAC to Dr. Griffin. If this structure is not possible, PSS and PSD need to figure out how to get the appropriate representation of Small Bodies to the Subcommittee.

The PSS was in favor of formation of the SBAG. Dr. Green indicated that he would endorse the proposed action. As this group is formed it should eliminate redundancies as well as include elements, such as planetary dust and elements from the former PSSMOWG (NEOs), that don't currently have a “home.”

Discussion of Recommendations

Dr. Neal was pleased to see a willingness of SMD to champion science as part of the lunar outpost. Science is an important player and should be included in the site selection process. Dr. Solomon asked Dr. Neal to draft a finding and proposed recommendation to through the Science Committee to the NAC.

In order to get buy-in for the PI requirements plan, there needs to be hard data on overruns that could be presented to the community. There should be on-ramps for PI experience from the planetary perspective. Dr. Stern will be looking very carefully at proposals that could potentially bust the “cap.” To date, there has only been one AO that includes the new PI requirements—Small Explorers (SMEX). Requirements will be scaled to cost; however, it is not clear whether requirements will be scaled to the cost cap or the proposed mission. The Subcommittee discussed this question.

Dr. Neal offered to do a Lunar Goals Document. Dr. Shearer indicated that he would like a response on CAPTEM's analysis and recommendation. Dr. Solomon asked Dr. Shearer to draft a finding and proposed recommendation.

Dr. Solomon indicated that he would include endorsement of the positive actions and events in his write up.

The next PSS meeting will be held March 3-4, 2008, at Carnegie Institution of Washington, Washington, DC. Topics will include: recent studies on cost overruns, the current thinking on MSR, a briefing on the LAT-2 Study, and a presentation on how Constellation Systems is responding to CAPTEM's request for greater “upmass” from the lunar surface. Dr. Green noted that several other topics of interest to the Subcommittee would be discussed as part of his update.

The meeting was adjourned at 6:45 p.m.

**Planetary Science Subcommittee Meeting  
7 October 2007  
The Rosen Centre Hotel  
9840 International Drive  
Orlando, Florida 32819**

7 October (8:30 AM – 5:00 PM)

|       |  |                             |
|-------|--|-----------------------------|
| 8:30  | Welcome & Administrative Matters   | Sean Solomon<br>Michael New |
| 8:45  | Planetary Science Division Update  | Jim Green                   |
| 10:45 | Break  |                             |
| 11:00 | Discussion   | Sean Solomon                |
| 12:00 | Lunch  |                             |
| 1:00  | Analysis Group Reports   |                             |
|       | - VExAG  | Janet Luhmann               |
|       | - Venus “Goals” Document   |                             |
|       | - Venus STDT   |                             |
|       | - Next VExAG Chair   |                             |
|       | - LEAG   | Clive Neal                  |
|       | - Update on FEAT   |                             |
|       | - Update on LAT-2 (if possible)  |                             |
|       | - MEPAG  | Vicky Hamilton              |
|       | - MSL (if not covered previously)  |                             |
|       | - OPAG   | Hal Weaver                  |
|       | - Discussion of formation of SBAG  | Hal Weaver                  |
|       | - CAPTEM   | Chip Shearer                |
| 3:30  | Q&A with the AA  | Alan Stern                  |
| 4:30  | Discussion, Formulation of Recommendations,<br>Planning of Future Meetings |                             |
| 5:30  | Adjourn  |                             |

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**Planetary Science Subcommittee Meeting  
October 7, 2007  
Rosen Centre Hotel  
Orlando, Florida**

**MEETING ATTENDEES**

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Solomon, Sean *Chair*  
New, Michael H. *Executive Secretary*

Carnegie Institution of Washington  
NASA Headquarters

Canup, Robin  
Dickerson, Patricia  
Hamilton, Vicky  
Hynek, Brian  
Luhmann, Janet  
Meadows, Victoria  
Neal, Charles  
Shearer, Charles  
Taylor, Lawrence  
Weaver, Hal

Southwest Research Institute  
University of Texas, Austin  
University of Hawaii  
University of Colorado, Boulder  
University of California, Berkeley  
University of Washington  
University of Notre Dame  
University of New Mexico  
University of Tennessee, Knoxville  
Johns Hopkins Applied Physics Laboratory

NASA Attendees:

Balant, Tibor  
Crane, Phill  
Green, Jim  
Johnson, Lindley  
McCouston, Doug  
McGrath, Melissa  
Pendleton, Yvonne  
Stern, Alan  
Zurek, Richard

NASA JPL  
NASA HQ  
NASA HQ  
NASA HQ  
NASA HQ  
NASA MSFC  
NASA HQ  
NASA HQ  
NASA JPL

Other Attendees

Durda, Dan  
Frankel, Paula  
Maurice, Sylvestre  
Esposito, Larry  
Weins, Roger

Southwest Research Institute/NASA HQ  
[consultant – Minute Recorder]  
CNES  
University of Colorado  
Los Alamos National Laboratory

**PLANETARY SCIENCE SUBCOMMITTEE  
Rosen Centre Hotel  
Orlando, Florida  
October 7, 2007**

LIST OF PRESENTATION MATERIAL<sup>1</sup>

- 1) Planetary Science Division Update [Green]
- 2) VExAG Update [Luhmann]
- 3) FEAT Update [Neal]
- 4) LEAG Update [Neal]
- 5) MEPAG Update [Hamilton]
- 6) OPAG Update [Weaver]
- 7) Formation of SBAG [Weaver]
- 8) CAPTEM Update [Shearer]

Other material distributed at the meeting:

- 1) Venus Exploration Goals, Objectives, Investigations, and Priorities: 2007; A Report of the Venus Exploration Analysis Group (VExAG) [hard copy and CD-ROM]

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<sup>1</sup> Presentation material is available electronically on the following Website: [www.science.hq.nasa.gov](http://www.science.hq.nasa.gov). After signing onto this site, go to “science strategy,” then “community input.”