

Planetary Science Subcommittee Meeting, March 30-31, 2015

National Aeronautics and Space Administration  
Washington, D.C.

NASA ADVISORY COUNCIL

## PLANETARY SCIENCE SUBCOMMITTEE

March 30-31, 2015  
NASA Headquarters  
Washington, D.C.

Meeting Minutes

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Jonathan Rall, Executive Secretary

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Janet Luhmann, Chairman

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### Welcome and Administrative Matters

Dr. Jonathan Rall, Executive Secretary of the Planetary Science Subcommittee (PSS), opened the meeting and made administrative announcements. Dr. Harry McSween, PSS Acting Chair, called the meeting to order. Introductions were made around the table.

### PSD Status and Findings Update

Dr. James Green, Director of the Planetary Science Division (PSD), reviewed the day's agenda and introduced the recently named Mars Program Manager, Dr. James Watzin. Dr. Green addressed a recent change in the NASA Advisory Council (NAC) infrastructure, which now excludes the subcommittee's Assessment Groups (AGs). AG meetings are now to be treated as conferences, and will be funded as such through NASA conference rules, with implications for increased paperwork. Both Dr. Green and the scientific community have expressed deep concern about this change in the NAC infrastructure.

Dr. Green praised the publication of a new textbook, Cosmochemistry, authored by Dr. McSween and Gary Huss, as a valuable addition to the planetary science library.

Dr. Green moved on to a report on PSD activities. In 2014, PSD announced the Mars 2020 rover selection, observed a Mars encounter with Comet Siding Spring, watched the Curiosity rover arrive at Mt. Sharp, participated in the Japanese Space Agency (JAXA) Hayabusa-2 mission, and provided support for the European Space Agency (ESA) Rosetta mission's landing on comet Churyumov-Gerasimenko; all are spectacular missions. More recently, the Dawn mission moved to a lower orbit around asteroid Ceres to prepare for a longer encounter. Mission reviews for the Europa mission are going well and PSD is currently planning a step-1 instrument selection. The Mercury Surface Space Environment Geochemistry and Ranging (MESSENGER) spacecraft continues to make science observations as it prepares for its scheduled impact into Mercury in late April. The New Horizons mission will fly by Pluto on 14 July 2015, providing the first close look at Pluto, which may reveal rings, dust, debris, and new moons. After the flyby the spacecraft will travel to the Kuiper Belt. Discovery 2014 step-1 selection announcements will be made in September. In March 2016, PSD will see the launch of the Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSIGHT) mission to Mars. The ESA mission Bepi-Colombo is slipping its launch date to January 2017, but its arrival date at Mercury will not change. In September 2016, the Origins Spectral Interpretation Resource Identification Security Regolith Explorer (OSIRIS-REx) mission will launch to Mars, and Cassini will begin to orbit into Saturn's rings.

PSD's top-line budget for 2015 is \$1.438B; Congress provided additional monies above the President's request, for which PSD is grateful. A total of \$165.4M was provided for Research and Analysis (R&A), as well as \$40M for Near-Earth Object (NEO) detection and characterization. The Discovery program received \$255M; \$286M was allotted for New Frontiers, and \$224.8M for OSIRIS-REx - the latter has passed its critical milestone, Key Decision Point D (KDP-D). PSD also obtained \$5M for a future New Frontiers mission; \$305M for Mars Exploration, including \$100M for the Mars 2020 rover (still in phase A), all of which meet the scientific objectives of the most recent planetary Decadal Survey. The Outer Planets (OP) program received

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\$181M, including \$100M for the Europa Clipper mission, indicating tremendous support in Congress for Europa. An allotment of \$155M was received for Technology, including support for Department of Energy (DOE) (Pu-238 production) interactions.

Addressing the 2016 budget, Dr. Green noted a steady increase in the top line from the years 2017-20, a better trend than seen in the recent past. For 2016, the President's request is for \$1.361B. There are several good-news aspects about the budget run-out, but it must be noted that Congress has passed a budget guideline that includes a potential 5% reduction in discretionary spending below the President's budget. There may also be sequestration cuts in 2016; these budget changes are still under discussion.

What has changed for PSD in the 2016 budget is that the Division now has a notional budget for Europa, allowing formulation (phase A) to commence and to move to more intensive studies. The New Frontiers (NF) future area now has a budget, thus PSD can start processing an Announcement of Opportunity (AO) for late 2016. PSD will eventually announce a firm schedule, but now is the time for the community to think about the next NF proposal. The new budget also maintains Stirling technology development for future radioisotope systems, and establishes a new Planetary Missions Program Office at the Marshall Space Flight Center (MSFC) to manage the Discovery, NF, JUPiter ICy moons Explorer (JUICE) and Europa flight Instruments.

Challenges to PSD include the fact that the Lunar Reconnaissance Orbiter (LRO) and the Mars Exploration Rover (MER) Opportunity are not included in the 2016 budget; PSD will therefore reassess the costs of maintaining both missions. Dr. Clive Neal commented that the Senior Review highly ranked these missions. Dr. Green pointed out that both LRO and Opportunity were also not in the 2015 budget; LRO had been included in the remaining activities of the waning Lunar Quest program, but has since been moved into the PSD Discovery program. Opportunity is in the Mars Exploration Program (MEP), which is currently short \$14M. The missions are running lean and mean and the program is trying to make ends meet. LRO and Opportunity will be re-assessed this summer. The Senior Review will help to drive these decisions, as well as the consideration of international partners and programmatic challenges. Asked how the committee can help, Dr. Green suggested PSS reaffirm the value of the Senior Review in providing scientific rationales for Extended Missions (EMs). A final change to the FY16 budget is a \$10M increase in funding for the NEO program to accelerate hazardous asteroid detection.

What's the same in the budget is the progression of OSIRIS-REx, and continuing development work on international collaborations for the Strofio, Mars Organic Molecule Analyzer (MOMA), and JUICE instruments. There is ongoing operational support for the international missions Rosetta, Mars Express, Akatsuki and Hayabusa-2. There is also support for mission operations, curation, and navigation tools, as well as for Pu-238 production.

The \$450M cost cap for Discovery excludes the launch vehicle and phase E (operations). The \$850M cost cap for NF makes the same exclusions. Future opportunities in Discovery are in planning to enable a 3-year launch cadence.

In the current New Frontiers program, New Horizons will be arriving at Pluto in July 2015, and Juno at Jupiter in 2016. PSD plans to perform data analysis for New Frontiers missions as the

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data come into the archive, and is considering a new element in the ROSES call to prepare for these New Frontiers missions. Dr. Green encouraged the community to start thinking about instruments and technologies to support the NF program. For Juno, the mission team has approved a slight change in orbit, from 11 days to 14 days, to provide better cadence in data acquisition. Dr. Nancy Chanover asked how the Picasso and Matisse programs fit into these plans. Dr. Green replied that the new draft would answer many questions.

PSD will soon solicit proposals for New Frontiers #4, following the Decadal Survey recommendations. The missions under consideration are Saturn Probes, Comet Surface Sample Return, a Venus *in-situ* Explorer, a Lunar South Pole Aiken Basin Explorer, and a Trojan Asteroid Tour and Rendezvous. Dr. Lori Glaze asked about funding profiles for the future years for New Frontiers missions. Dr. Green felt that what had worked well for Juno was an extended phase B, which might well turn out to be a canonical approach to New Frontiers missions, as it is good for risk reduction. Dr. Nancy Chabot asked how taking phase E money out of New Frontiers cost caps affected the cadence. Dr. Green replied that the strategy helps to keep missions in a linear time frame according to Decadal Survey recommendations, and helps avoid penalizing missions that take longer times to reach their targets. For New Frontiers call #5, a Lunar Geophysical Network and an Io Observer will be added to the remaining list of candidates.

The Mars Program is maintaining many operational missions at Mars, in concert with both the Indian Space Research Organization (ISRO) Mars Orbiter Mission (MOM), Mars Atmosphere and Volatile Evolution Mission (MAVEN), Mars Reconnaissance Orbiter (MRO), Mars Express, Mars Odyssey, Opportunity and Curiosity are in current operations. Missions planned for 2016 are the ESA Trace Gas Orbiter, and InSIGHT, and an ESA Mars Rover is planned for 2018. Mars Exploration Rover (MER) Opportunity recently marked its “marathon” run (26<sup>th</sup> mile traversed) on the planet. Progress is being made on the Mars 2020 rover, with connections being made with France, Spain and Norway for contributing instruments.

The Europa Clipper mission is scheduled to enter phase A in June after instrument selection. PSD is evaluating 33 proposals, and selections are expected in May. Hubble Space Telescope (HST) time has been dedicated to verify the existence of Europa plumes. In February 2015, a workshop was held on techniques for life detection at Europa; the workshop report is nearing completion and will be made available. Europa mission formulation continues. The Clipper concept is a spacecraft that makes multiple flybys with ice-penetrating radar, magnetometers, and a variety of instruments that will provide global coverage of the moon. Data from 12 Galileo passes is still to be analyzed.

Dr. Green announced a community challenge related to increasing the number of planetary proposals to astrophysics telescope assets. One exciting result that has emerged is novel data about the seismology of Neptune (via the Kepler imager). Spitzer has experienced a five-fold increase in planetary proposals compared to the prior cycle. Chandra is detecting x-ray emissions from comets. HST recently imaged three Kuiper Belt Objects (KBO) for potential New Horizons fly-bys; HST is also observing Europa for the presence of plumes. The next community challenge is to learn about the Pluto system and Ceres; NASA has placed approved project presentations on the Small Bodies Analysis Group (SBAG) and Outer Planet Analysis Group (OPAG) websites, and is requesting that the community take on the role as local experts, giving public and departmental talks to spread the news about these exciting new encounters.

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Dr. Green addressed 2 of the top five recent PSS findings. Finding #3 had requested that PSD make available the results of the Request for Information (RFI) for the \$1B Europa mission. NASA received 6 responses to the RFI, and carried out independent Cost Analysis and Technical Evaluation (CATE) exercises. It was concluded that missions close to the \$1B target minimally addressed a fraction of the Decadal Survey science, and required new technology and potential follow-on missions. Dr. McSween commended Dr. Green for obtaining independent cost estimates for the Europa RFI, but was disappointed in how little one can do for \$1B. Dr. Green acknowledged that the price of doing planetary science is high, and PSD is on the hook to demonstrate the value of planetary missions; he further encouraged the community to spread the word. While he felt that Europa is not really a New Frontiers mission, he felt good about the concept studies received; there is no reason to believe that there is a hidden idea out there for getting to Europa on \$1B.

Finding #5 on foreign missions was also addressed. NASA has an extensive portfolio relative to ESA, and is contributing to Rosetta, Bepi-Colombo, JUICE, Mars Express, Exomars Rovers, and the Mars Trace Gas Orbiter. ESA announced an M4 competition in August; NASA PSD is participating through the normal process, and sent 7 statements of interest. ESA is in the process of evaluating proposals. Selections should be announced shortly. The bottom line for PSD is that NASA is involved in every possible planetary mission led by ESA. A South Korean lunar mission is also being considered through a discussion with the Human Exploration and Operations Mission Directorate (HEOMD). Dr. Larry Nittler asked if there were plans for a Guest Investigator (GI) program in the ESA missions. Dr. Green replied that the JUICE mission will call for Participating Scientists as the mission gets closer to launch. NASA is also working with the Japanese Space Agency (JAXA) on Hayabusa-2, and will be obtaining 10% of the returned sample. NASA will also have Participating Scientists in this mission. NASA is also involved in the Akatsuki mission with long-term data archiving and Participating Scientists. NASA has worked with ISRO on the Moon Mineralogy Mapper, is supporting the current MOM mission, and now has been approved to enter into a discussion for chartering a Working Group that will govern data exchange between existing Mars missions. The possibility of enhanced cooperation for future missions is also being explored, as ISRO plans to return to Mars.

Asked why PSD was re-opening the Hayabusa step-1 call, Dr. Rall explained that PSD was addressing a couple of people who had missed the deadline, and simply wanted to be as transparent as possible. Dr. McSween noted that the Decadal Survey advocates a regular two-year cadence for Discovery; is 3 years going to be normal going forward? Dr. Green replied that he was working to enhance the budget to make it possible and is doing everything possible to step up to the Decadal Survey recommendations. Dr. Chabot added that everyone wants to see LRO and Opportunity continue. Dr. Green commented that NASA has tried very hard to shield Research and Analysis (R&A) from the more draconian cuts in the past; PSD has also been trying to give people opportunities to propose and keep R&A selection rates healthy, and is trying to balance the program as the economy goes through its ups and downs.

Dr. Neal felt that the accumulation of new data in the Planetary Data System (PDS) argued for more money in the R&A program. Dr. Green allowed that this could be a topic for discussion; does it argue for slowing down launch cadence? He was well aware that R&A needs new funding. Asked about a potential NEO space-based survey, Dr. Green related that the latest charge from the Science Committee is to delineate where the Decadal Survey indicates support

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for such a survey, and such support has been provided. Dr. Chabot surmised that the Science Committee might think that the NEO survey is not necessarily PSD's responsibility. Dr. Green noted that it is the authorizers in Congress that tell NASA where to spend, and the appropriators that supply NASA with the money to spend. The authorizers have challenged PSD to find hazardous NEOs and the Administration continues to support this challenge; however, there is a mismatch currently between authorizers and appropriators. He pointed to a strong PSS finding that NEOs should be a NASA priority and not only a PSD priority.

Dr. Turtle asked, with respect to an increased cadence in Discovery and New Frontiers, if there had been any discussion on how to address an overlap in targets. Dr. Green expected that proposals would stand on their own with well-focused science, thereby helping to decide missions through competition.

### PSD R&A and Findings Update

Dr. Rall reviewed the PSD response to PSS findings on acquiring representation in the AGs from astrogeology; as a result, Drs. Jim Skinner and Samuel Laurence have stood up an AG called CRAG, for the Cartography Research Analysis Group. Another finding was on developing metrics and criteria for defining balance in the R&A program. PSD has a set of key words that can be used in the database to help demonstrate these criteria. The R&A program is almost through its first cycle; the only pending category is Habitable Worlds. Thus far there has been a consistent 25% reduction between step-1 and step-2 proposals; selection rates vary but average about 21% across programs, except for Picasso, Matisse (15-16%) and PSTAR. Dr. Mary Voytek briefly addressed the mapping of programs from old to new, which can be tracked by target (Mars, OP, e.g.). She added that most proposers have been able to answer questions related to targets, disciplines, types of data, and types of tasks.

Dr. Rall reported on trends in the R&A program from 2004-2013. A total of 13,300 proposals were submitted during this period. Trends reflect flat or slightly increased funding during budget dips; the amount of money PSD has been releasing for R&A has been increasing, generally. Dr. Neal concurred that even in lean budget years, PSD has preserved the budget for R&A. Dr. Voytek added that PSD wanted to show that there were also fluctuations in the numbers of proposals per year. As to the success of core programs from 2004-13, the trend is down, except for planetary astronomy, which had added funding from the NEO appropriation. Dr. Lisa Pratt commented that it seems like the number of proposals is down while the money is up? Dr. Michael New stepped in with a chart to answer that assertion. He commented that in the old system, the programs grew organically and were based on historic growth. PSD didn't set budgets by budget history. Dr. Glaze voiced the community's concern about the balance of programs, and asked what PSD strategy governs the balance. Dr. Rall and Dr. Green emphasized that looking for life in the solar system is the basis of much NASA research, despite new mapping of programs in R&A. PSS in the past has ensured that all elements in the core program were re-mapped to the new program. Dr. Green noted that the PSS is now seeing everything PSD has funded in the past, just organized differently, based on recommendations from both the National Academies of Science and PSS itself. It is now time to step back and improve how PSD solicits proposals.

Dr. New provided some commentary on the revamped R&A program, adding that by removing variation associated with the number of solicitations, the data indicate that the number of

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proposals increased over the period under discussion. It was further noted that universities represented the majority of proposers, while there was a slight increase in proposals from nonprofit organizations and NASA centers. There was also an increase in people submitting more than one proposal. Dr. McSween observed that when some lunar activities were absorbed into PSD, proposal pressure was increased. Dr. Green concurred with this assessment.

Dr. Voytek provided background on why astrobiology is in PSD, based the findings of a Space Science Workshop in 1996. The subject of astrobiology has subsequently attracted \$1B to the Science Mission Directorate (SMD). At one point in time, astrobiology was allotted \$65M, which was cut in half; subsequently, Dr. Green has been trying to rebuild the astrobiology program. This information should be shared in the community to reduce infighting. The primary categories of proposals in Solar System Workings (SSW) include interiors, surfaces, atmospheres, etc. Selection rates are varying from 16 to 27%. Selection rates for proposals by target are: Outer Planets, 25%; Venus, 23%; Mercury alone, 0; Mercury in comparative studies, 27%. The general range by target is from 18-29%. Proposals by discipline, such as dynamics, chemistry, geology and cosmochemistry, range from 17%-30%. By task type, such as ground-based observation and sample analysis, the range is 14-30%. By merit of proposals in SSW, PSD selected 100% of Excellents, 88% of Excellent/Very Goods, 3% of Very Goods, and 0% of any lower merit categories. Dr. Chabot commented that she was not convinced that there is a difference between Excellent and Very Good. Dr. Glaze suggested that PSD could sift proposals, after leveling, by “must fund,” “fund if possible,” or “do not fund” categories. Dr. Timothy McCoy was curious as to why there was no effort to get new money for the new R&A programs, in order to address Decadal Survey recommendations.

### Mars Exploration Program Update

The new Program Manager for the Mars Exploration Program (MEP), Dr. James Watzin, provided an update on Mars activities, noting that Mars has been in the headlines frequently. MAVEN has arrived at Mars, and of note, MRO HiRIse recently located ESA’s lost Beagle lander. Curiosity is actively engaged in exploring Gale Crater. Mars Odyssey continues to provide valuable relay and imaging services. Overall the program is very healthy. MRO is exploring future landing sites for both NASA and international partners. Curiosity has arrived at Mt. Sharp, and is currently addressing a short-circuit anomaly. Mars 2020 is proceeding to Key Decision Point-B (KDP-B), a precursor to the Preliminary Design Review (PDR) milestone. The Mars Organic Molecule Analyzer (MOMA) instrument is in flight fabrication for the ExoMars mission launching in 2018. MEP has delivered and integrated 2 Electra units for ESA’s Mars Trace Gas Orbiter. In FY16, the program has the budget to continue development for the NASA Mars 2020 rover, as current assets continue to add to an increased understanding of the Martian system. Radar observations and optical sensing from MRO are helping to establish a better understanding of CO<sub>2</sub>, while Curiosity is continuing data collection, having detected organics and nitrates in the soil. Opportunity is continuing its mineralogical ground truth verification for MRO.

The Mars 2020 rover mission has made excellent progress and has completed accommodation reviews for selected payloads. The Standing Review Board (SRB) will report out within the next several weeks, but has been preliminarily quoted that it regards the 2020 mission as “judged as more mature than most phase A projects.” The mission is continuing to evaluate a Terrain Relative Navigation (TRN) capability for the rover, and has decided that there is adequate



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coverage for data relay; thus the mission has dropped the trade study for direct-to-Earth (DTE) communication. Instead, 2020 will rely on the Mars Odyssey satellite and on some redundant systems on the future Trace Gas Orbiter. A capability for a wide-angle topographic sensor (hand-lens) has been added back into the system, and the Entry, Descent and Landing (EDL) camera has been augmented to evaluate the system more closely.

The Critical Design Review (CDR) for the MOMA mass spectrometer (MS) instrument development has been completed. The ExoMars 2018 mission PDR will be completed by May 2015. Challenges to ExoMars include an issue with the delivery of MOMA-gas chromatograph (Canadian Space Agency; CNES), and a significant delay (10-17 months) in the delivery of a flight laser provided by the German Aerospace Center (DLR); the latter delay is not expected to have an impact on the mission. The MOMA-MS Flight Model delivery to the Max Planck Institute is expected to be on time.

For future human exploration of Mars, it will be necessary to identify hazards and resources, expand engineering knowledge, and identify supportive technologies. It is time to start thinking about the post-2020 mission line at Mars. Dr. Watzin felt the 2020s would be a transitional era, in that science will increasingly inform human exploration, and vice versa. Therefore, HEOMD and SMD must explore synergistic partnerships to identify *in situ* resources, develop return-trip capabilities, and develop infrastructure (telecomm, surface reconnaissance). Dr. McSween remarked that sample caching did not seem to be included in the presentation, despite its prominence in the Decadal Survey. Dr. Watzin noted that caching is hidden in the return-trip wording. Dr. Neal saw a lack of planetary protection requirements that are critical to sample return and risk mitigation. Dr. Watzin assured PSS that planetary protection is part of systematic requirements, and is a real and significant portion of the end-to-end journey. It has been a big element in the development of the 2020 rover. Dr. Pratt expressed surprise that some changes for 2020 were driven by engineering concerns. Dr. Watzin replied that one was seeing an evolution of design, and not changes necessarily. In addition, the mission team is also reaching out for feedback. The mission is still a work in progress that will be solidified by the PDR in the Fall. Dr. Pratt noted that 2020 must also consider the Decadal Survey recommendations on sample type, size, etc.

Dr. Watzin outlined the MEP future vision as rich in possibilities for partnering with HEOMD and the Space Technology Mission Directorate (STMD), and to that end described the initiation of a joint MEP/HEOMD/STMD working group and a MEPAG Sample Assessment Group (SAG) to address these potential partnerships. In the notional evolution of MEP, an orbiter is a logical next step after 2020, to include telecommunications relay and surface reconnaissance capabilities. In summary, MEP is healthy and improving. Decadal Survey priorities are guiding its future planning. It is time to begin studies and assessment of options for the next step after 2020, and to examine synergies with HEOMD and STMD. Dr. McSween asked for more detail about a sample return mission, and encouraged Dr. Watzin to explicitly include such information in future briefings. Dr. Mihaly Horanyi asked why another orbiter should be the next step after a 2020 rover. Dr. Watzin replied that an orbiter would be tasked with remote sensing of concentrated resources (resource prospecting) for ISRU, and would serve as a refreshing and expanding communications relay (including optical communications). An orbiter could also demonstrate solar electric propulsion (SEP) for interplanetary flight for both sample return and for maneuvering orbits around Mars. Dr. Chabot asked whether an orbiter could be funded by other

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divisions as well. Dr. Watzin stated that these partnerships are under discussion. Dr. McSween, referring to the addition of a hand-lens capability to the 2020 payload, asked how it was selected outside of a formal proposal process. Dr. Watzin explained that the team went back to a proposal for another capability that had not been selected.

Dr. Janet Luhmann, Chair of PSS, commented that the long-term planning for Mars had begun to wander away from the PSD core mission in that it is now considering the human side, becoming more and more a joint activity. The role of science seems murky, and science goals do not appear to be obvious. She asked if there would be some revisiting of the long-term Mars plan in light of the next Decadal Survey. Dr. Watzin felt that the HEOMD is beginning to recognize the importance of science. MEPAG is not walking away from science but trying to leverage more out of it. Dr. Luhmann commented that sample return is not contingent on getting humans to Mars, and that there does not appear to be enough program concentration on sample return. Dr. Watzin replied that the next step after 2020 would be the orbiter, which can also address sample return. The program does not yet have a Mars ascent vehicle, nor cached samples; planning for sample return will require a sequence of steps. Dr. McSween noted that the National Research Council *Safe on Mars* study concluded that there are critical science questions for future human exploration that can only be answered by sample return. Dr. Pratt commented that compelling science activities for humans to carry out must also be identified, given that surface operations are expected to run for two years. Dr. Green added that future missions will be better defined as we go further in time.

### NASA Advisory Structure and Process

Dr. Green addressed the recent changes in the structure and organizational processes of the NAC, which now defines AG meetings as conferences, entailing an increase in complexity in bringing community input to the science subcommittees. The changes reduce the ability of the subcommittees and Science Committee to provide findings. PSD has the most AGs in SMD, and has most at stake with this issue. Currently, conferences must go through a proposal process, peer review, and funding allocation. Dr. Green has proposed that PSS execute a Working Group process to replace the AGs. This had been done in the past with an R&A Working Group. In this process, the WG would address well-defined, topical tasks, such as reviewing the next step in Asteroid Redirect Mission (ARM). For Outer Planets, a Working Group (WG) might be relative to Europa. PSD is preparing for a mid-decadal review, which will also require community input. As an example, instead of SBAG, a PSS Small Bodies Subgroup could be created to provide findings for disposition by the subcommittees. Dr. Green has proposed this process to the NASA legal office and is awaiting disposition. The WGs would not need to be public, necessarily. Dr. New commented that in the past, NASA had treated unchartered WGs as chartered. Dr. Green acknowledged this. Another idea was that the particular community could meet at appropriate conferences, such as DPS, but this was acknowledged as awkward.

Dr. Green discussed, as a sample problem, the caching issue with the Mars 2020 rover; there is obviously more community input needed. For now, the next Venus Exploration AG (VEXAG) meeting is going forward under the conference rules; Dr. Glaze described the process as quite cumbersome, particularly as it requires staff at a NASA center. There is also an artificial limit on the number of attendees; they can't be added to the list after the process is closed without a justification. Dr. Green noted that the Lunar and Planetary Science Conference (LPSC) almost

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didn't happen this year because of bureaucratic formalities and cost levels. Dr. Amy Mainzer felt that the SBAG meetings help to give a good snapshot of community priorities and that it would be harmful to disassemble SBAG. Dr. Green encouraged the community to see how the WG suggestion pans out. It wouldn't do to put pressure on other entities. While the issue is primarily one for PSS as it has the most AGs, the rest of SMD could benefit from attempting to solve the issue for all of SMD. Dr. Luhmann asked if AGs could continue as Webex meetings, with Town Halls at major meetings. Dr. Green reported that when PSD did an R&A Town Hall, it encountered many online trolls. Dr. Neal commented that it seems better to work with the system, and to be more structured and specified. He asked: if the AGs are muted, then how does PSS maintain its representation, if AG chairs don't automatically sit on the PSS? Dr. Green noted that when new members are needed, attention is paid to the subdisciplines. Dr. Rall added that community members can nominate, and also self-nominate. Dr. McSween asked whether the various groups could help to define a topic for each year. Dr. McCoy observed that the Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM) has many committees that sit underneath it. Dr. Mackwell explained that under the current system, CAPTEM will probably qualify as an operational meeting or a peer review group. The definition of a conference is where NASA is the only or primary sponsor.

Asked about the future of the CRAG, Dr. Green noted that it is a work in progress. First, their role needs to be fleshed out; they may be considered to be more like CAPTEM. Dr. Glaze thanked Dr. Green for his attempts to find a solution; the WG idea sounds like it's worth pursuing. She asked if there were a possibility for getting the AGs back into the structure. Dr. Green replied that once the lawyers get a ruling on intent, he could address the question. Dr. McSween commented that the National Research Council (NRC) also draw on the AGs' expertise, in the form of white papers to support the Decadal Survey. Dr. Mackwell noted that since the AGs bubble up from the community, they can continue to meet and request money from NASA to run a conference. The only difference is that when a NASA employee or contractor attends an AG meeting, the meeting must be treated as a conference.

Dr. Max Bernstein addressed the issue, citing concurrence from Dr. Paul Hertz in the Astrophysics Division (APD) and Dr. Gale Allen in Office of the Chief Scientist, OCS, who both agreed that the AGs could request meeting time at a PSS meeting, and support it as a grant for a public purpose in response to a ROSES call. Drs. Hertz and Allen agreed that a subcommittee could also request an AG briefing be put on the schedule of any meeting.

Dr. McSween requested some written direction on this matter, which Dr. Rall took as an action.

Dr. McSween expressed concern that the AG restructuring may be construed as a NASA rejection of community input. Dr. Green explicitly stated for the record that is not the case, and hoped that by the next PSS meeting, a clear approach will have been established. Dr. Chabot, speaking for SBAG, expressed appreciation for past support from PSD.

Dr. Nittler, referring to an open letter from community on normalizing the R&A program to a 20% selection rate, observed that there is a perception in the cosmochemistry community that there is a higher barrier (sophisticated instrumentation) to a higher selection rate, and therefore may represent a smaller number of proposal submissions. He asked if NASA had a way to refute this perception, and whether other programs have a higher rate of poorer proposals. Dr. Rall

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replied that it is recognized that cosmochemistry is hard to get into; the intent was not to unfairly take money away from it. The intent was to align it more with strategic objectives. This is the first year of a re-organization, and cosmochemistry is now competing with other categories in a different venue; they are a group of folks that have been rather protected in the past, and are now playing on a more level field. Cosmochemistry can no longer expect 40% selection rates. Dr. Green commented that Solar System Workings and Emerging Worlds have hopefully opened opportunities for cosmochemistry, and that PSD will assess this after one complete cycle. Maybe PSD needs to do more detailed analysis on how the reorganization affected proposal writing. Dr. Green encouraged everyone in the community to look at the top proposals and note their characteristics. Dr. Jeff Grossman commented that the main change in Emerging World proposals is that the proposers were competing in a bigger pool, but the proposals were reviewed very well. Dr. Neal noted that one outcome from the open letter is to identify in what capabilities we might be in danger of falling behind; preserving capabilities and leadership is important. Dr. McSween felt it was incumbent on the astromaterials community to help define and design future missions. To this end, CAPTEM is writing a white paper, as is the group that penned the open letter. The community needs to make a case for identifying what analytical techniques will be necessary in the future. Dr. Pratt commented that many scientists who run large expensive labs do so with funding from multiple agencies; therefore, it is necessary to identify critical science that can only happen in these labs. Dr. Neal requested copies of the new charter for the NAC. Dr. Rall agreed to distribute copies, and noted that the charter is available online.

Dr. Chanover asked for an elaboration on a New Frontiers Data Analysis Program (DAP) that might be parallel to a Discovery DAP. Dr. Rall explained that New Horizons will have a rolling archival responsibility, which is TBD based on the amount of data. After this is determined, PSD will issue a call for proposals for data analysis using New Horizons data. The division is also trying to get out a call in the next couple of weeks for instruments for the New Frontiers #4 call. Dr. Chanover asked about the nature of discussions taking place between STMD and PSD for technologies relevant to planetary missions. Dr. Rall replied that in the Discovery call, there were a number of STMD technologies to test. PSD is renewing its connection with STMD leadership, and currently has memoranda of understanding (MOUs) in Discovery with STMD. A similar discussion for New Frontiers has not yet taken place. It must be noted that STMD is limited by a slightly more constrained budget; but they are obligated to develop optical communications, which will be critical for planetary missions.

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Dr. McSween opened the meeting, reviewed the agenda, and commenced a discussion on potential findings.

PSS considered a finding on the Mars program, applauding SMD's increased connectivity with HEOMD and STMD, but recommending that SMD should increase the Mars program's science focus, on sample return in particular, filling strategic knowledge gaps (SKGs), mapping resources, and planning technical demonstrations for humans at Mars. Dr. Glaze suggested adding a statement on the long-term view for sample return. Dr. House expressed concern with the statement that mapping resources was a science goal. This is backwards: science should drive the process. Dr. Horanyi urged a clearer look at the big picture.

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Dr. McSween offered a second finding for discussion, suggesting that once PSD has a full year's experience with the re-organized R&A program, PSS should review it. Given that NASA is mission-oriented, PSD should consider other models besides fixed-rate selections for all programs. Dr. Gaddis did not quite agree with needing other models. Dr. Rall noted that PSD can start to do course corrections, and that ideally PSD can react to feedback appropriately. Dr. Horanyi felt selection rates did not need to be tweaked - only community response. He suggested that PSD assign available funds to what it needs. Dr. Neal, speaking with regard to Solar System Workings (SSW), felt that it seemed too broad a program to allow effective representation on review panels. Dr. Rall replied that PSD is planning to have two step-2 calls about 6 months apart for SSW this year, to spread it out over time, having recognized that it was not healthy to have such a large call. Dr. McCoy requested a future briefing that would include how selection rate varied with score across all the newly created programs, and how the budgets were aligned, for a PSD-level view vs. the SSW view. Dr. Luhmann commented that PSS must recognize that the community is adjusting to new directions and that there is a lot of iterative correction going on here. In addition there is an element of program definition that is steering the community, as well as selection rates and strategic goals. Dr. Glaze suggested that PSS second the OPAG finding that calls for more communication during the year. Dr. McSween acknowledged that PSS was calling for more quantitative information on R&A, and asked Dr. McCoy to craft the finding. Dr. Neal cautioned against asking for more and more information and to make sure that the finding is a focused request. The community should not keep NASA from doing its job.

### CAPTEM

Dr. McSween reported on the latest CAPTEM activities. There have been many recent changes in personnel. A summary of astromaterials allocations by year shows another banner year in 2015; sample requests are increasing. A downturn in requests for lunar samples in 2014 reflects the fact that thousands of samples are now being repatriated. Allocation of meteorites was temporarily affected by an ice bridge collapse in Antarctica, preventing samples being returned. New actions for CAPTEM include a new responsibility for space-exposed hardware at Johnson Space Center (JSC). CAPTEM recently approved and delivered a report on the cleanliness of the Lunar Curation Facility (responding to new technologies for analyzing samples), and will co-sponsor a Stardust Workshop in Berkeley this summer.

Astromaterials will provide support for new missions in formulation, such as OSIRIS-REx, Hayabusa-2, Mars 2020, and ARM. Astromaterials outreach activities include distribution of educational sample discs to thousands of students worldwide, and new social media sites.

### *ANSMET*

Science nuggets focused on the 35<sup>th</sup> anniversary for the curation of Antarctic meteorites at JSC, which is being recognized by the publication of 35 Seasons of US Antarctic Meteorites, recently published by the American Geophysical Union (AGU). The Smithsonian Institution, NASA and the National Science Foundation (NSF) manage these meteorites. A total of 20,700 meteorites have been collected since 1977, representing a tremendous resource for the astromaterials community. Currently, there are about 100 proposals for sample loans annually, and about 700-800 specimens are prepared and loaned annually. The collection is used worldwide. Bodies represented in the Antarctic Search for Meteorites (ANSMET) collection include at least 80 parent asteroids, Moon and Mars. ANSMET research has enabled more than 10,000 publications,

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at a rate of 50 papers per year, with an increasing trend. Top discoveries from ANSMET include the first meteorite from Mars being recognized from this collection. The Allan Hills meteorite (ALH84001) helped to expand the scope for NASA's current campaign at Mars.

### *CAPTEM findings*

CAPTEM finds that Discovery and New Frontiers AO language is not consistent with larger missions with respect to sample return. Language for smaller missions states that "75% of returned samples shall be preserved for future study." CAPTEM suggests this language apply to all missions, both robotic and human. Furthermore, each NASA institutional scientific collection should have a policy for long-term use of the samples, including several considerations on the uniqueness of samples, origin, etc.

CAPTEM finds that the reorganization of R&A in PSD has caused solar system sample research to have been negatively impacted during the first year of re-structuring. CAPTEM is concerned about diminishing astromaterials research capability, which may cause harm to SMD's planetary exploration mission and US leadership in extraterrestrial materials research. CAPTEM will issue a white paper on this matter. Dr. Pratt suggested adding to this finding the special need for more diversified laboratories for analyzing these materials.

### LEAG

Dr. Neal reported on the Lunar Exploration Analysis Group (LEAG), which has undergone some recent changes in its executive committee membership. The Volatile Specific Action Team, requested by HEOMD to assess recent discoveries related to detection of volatiles at the Moon, produced 7 orbital findings and 8 surface findings. Its final report is available on the LEAG website. Recent activities include the first LEAG "Next Gen" networking session at a recent LPSC meeting, meant to make connections between up-and-coming young scientists and seasoned veterans. In community news, a special issue *Icarus* featuring LRO is being published (submissions are due June 2015). New microCT capabilities will be coming soon to JSC.

There is deep community concern over the LRO budget and an apparent disregard for the Senior Review process. The LRO Education Team will be presenting a Lunar Workshop for Educators. Future initiatives include an International Lunar Workshop, and New Views of the Moon II (NVM II). The next LEAG meeting will be held in October 2015. The LEAG is considering a potential Specific Action Team on preservation of knowledge base for astronaut training, to help address increasing concern about a lack of continuity for training of astronauts for human surface operations at asteroids, the Moon, etc. LEAG is discussing this with HEOMD. Dr. Pratt commented that such an activity may have some direct relevance to planetary science, as MEPAG is already considering site selection for humans on Mars. Dr. McSween asked Dr. Neal to draft a PSS finding on this potential LEAG activity, for later consideration.

Final LEAG issues for PSD include whether the next New Frontiers/Discovery call will play a potential role for filling SKGs; the fate of LRO and Opportunity Extended Missions; and obtaining clarified guidelines for conference travel.

Dr. Neal presented science nuggets from recent lunar observations, including newly resolved

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Hapke parameters, “lunar swirl” data from LRO (caused by intense magnetic fields), and data on the dielectric charging of areas on airless bodies. Two recent papers based on Apollo samples were published, one on the dating of bombardment history on the Moon, and one on the Schrodinger basin, a geologically rich area on the “far side” of the Moon.

Dr. Chanover suggested, given the LEAG findings, to raise LRO and Opportunity concerns as a finding for PSS. Dr. McSween requested that Dr. Chanover write the finding. Dr. Neal informed PSS that he had received an email indicating that the Chinese Chang’e mission is open for contributions, for payloads for the rover/lander.

### MEPAG

Dr. Pratt reported on recent activities of the MEPAG, first noting that the Mars program is currently dealing with Curiosity wheel problems and vibration issues with the drill. Recent data from Mars assets have signaled a major shift in the characterization of early Mars (cold, chilly vs. warm, wet). At the most recent MEPAG meeting, the new leadership at the MEP spent two days with the MEPAG community. MEPAG received updates on various missions, including the Mars 2020 drilling/caching system, and changes in caching strategies and mission architecture. A briefing on ExoMars planning included concerns about a Russian launch, given the political situation. MEPAG also discussed JAXA partnerships and an increasing partnership with ISRO. There has been much community effort in the last 6-9 months in updating the MEPAG Goals Document in order to realign its science goals with current understanding, increase cohesion and usability of the document, prepare for upcoming activities such as new analysis groups, and add a new sub-objective level to the hierarchy. There also has been increased interest in the MAVEN mission, as well as future landing site selection activity for various missions. It will be crucial to identify a landing site that will keep human explorers busy for a two-year surface campaign. MEPAG members are getting to know the new leadership, particularly with a focus on the Mars 2020 mission. The addition to the 2020 payload of a hand-lens for fine-scale imaging will be exciting for the community. MEPAG has had requests from NASA to consider a possible new orbiter for 2022/24, and potential science objectives for a human mission in the 2030s.

Dr. Pratt presented science highlights, such as a MAVEN discovery on solar-wind ions that are burrowing deeper than theorized into the atmosphere of Mars, and the observation of ultraviolet aurorae on Mars. Exciting images from ISRO’s MOM are supplementing imagery from HST. MRO has detected evidence of landslides and has collected new data on mineralogy, as well as the detection and distribution of CO<sub>2</sub>, and identification of cold-traps. Remote imagery has shown the Curiosity trace in the Pahrump Hills, through sandstone strata. There are potential science findings on 10-carbon-chain compounds. Discoveries of features such as recurrent slope lineae (RSLs) will have an enormous impact on future human activities, thus the community must keep an eye on science objectives as HEOMD moves forward with human mission planning. Dr. Pratt suggested that new Mars observations could be a finding-level subject, as NASA should be providing educational materials on these.

### OPAG

Dr. Turtle reported on Outer Planets Analysis Group (OPAG) activities. The group has been working on a science Goals Document, in a first review since 2006; the document in progress is

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posted on the OPAG website. OPAG had its most recent meeting in February, and held a Town Hall meeting at LPSC. The near-term future for Outer Planets is great: Juno is approaching Jupiter, Cassini is at Saturn, and New Horizons is arriving at Pluto soon. Soon afterward, the community anticipates the ESA mission JUICE, New Horizons at a KBO, and a Europa mission in formulation.

OPAG findings strongly support moving ahead with Europa mission. There is a concern with possible modifications to the mission related to plume discovery. Plume instruments are only to be considered if there is no detriment to cost and schedule. A workshop on assessing habitability and life detection in plumes produced no consensus on how to best detect living organisms. OPAG recommends the Picasso and Matisse programs as a focus for supportive research on life detection.

OPAG finds that a focus on Cassini's legacy should include support for a continuing Cassini Data Analysis Program (CDAP) or possibly an OP-DAP, until the Europa mission is on its way, to help bridge the large gap before the next outer Solar System mission.

Recognizing the funding challenges PSD has faced, an OPAG finding applauds the support for the New Frontiers program.

OPAG endorses removal of phase E costs by PSD, and giving the Outer Solar System (OSS) mission line a home in Discovery.

OPAG recognizes the challenges of traverse time to OSS targets. The Space Launch System (SLS) could shorten this time, but there is concern about the lack of cost models for SLS launches. The power to reach targets in the OSS is also a concern. There is still a need to maintain development of Pu-238 and radioisotope thermal generators (RTGs) in general, and Stirling engines in particular. OPAG finds no specific need to develop fission power.

OPAG urges investment in future technologies, and release of a report on new power systems as soon as possible.

OPAG is naturally concerned about funding levels and selection rates in the R&A programs. OPAG findings support an increase in program funding to improve the selection rate, and to improve communication through quarterly Town Hall meetings between the community and NASA program managers.

OPAG expresses support for collaborative international partnerships, and encourages NASA to look ahead to identify opportunities and find mechanisms to enable collaboration on high-priority projects.

OPAG encourages Earth-based observations in the US and internationally to leverage science returns from active missions.

OPAG encourages NASA to continue funding Early Career Fellowships (ECFs) and to consider ways to include ECFs in planetary missions from phase A-E, and to continue to monitor the involvement of Early Career scientists in planetary missions and R&A.



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### *Discussion*

Dr. Chanover commented that instrument development for biological signatures may be hindered by the fact that Matisse is not offered this year. Dr. Rall noted that Matisse is to be offered every other year; PSD is now looking at selecting Matisse-type instruments with Europa technology funding. Asked about a CDAP program extension, Dr. Rall replied that there are discussions about 2020 being the timeframe for this extension.

### SBAG

Dr. Chabot reported on the latest activities of the Small Bodies Assessment Group (SBAG), which held its last meeting in January, in coordination with the AstroRecon meeting at Arizona State University. Findings are posted on the SBAG website. This year is a banner year for small bodies; missions will attract a huge amount of attention and present a great opportunity to engage the public.

SBAG findings include a reiteration of the importance of a space-based NEO telescope; this should be an agency-wide goal to achieve the NASA Asteroid Initiative and Asteroid Grand Challenge. PSS had issued a congruent finding in September 2014. Dr. Neal noted that this finding is still with the Science Committee. Dr. Luhmann explained that the issue is still the lack of explicit mention of this mission in the Decadal Survey. Despite demonstration of the language in the Decadal Survey, this evidence seemed insufficient for moving the finding forward to the NAC. There has been dialogue between Science Committee chair and others, but the issue seems to be tabled. Informally, the Committee chair spoke with HEO et al. about the mission and there is continuing discussion. Dr. McSween felt it might be helpful to bring the matter before the Science Committee once more.

SBAG strongly supports the NAC statement on support for a human mission to an asteroid in its native orbit, which has unique merits and value.

SBAG supports continued engagement with the NASA ARM team as the concept is defined.

SBAG regards the Decadal Survey recommendation on the two-year cadence for the Discovery program as an essential guideline, and would like the PSS to take this as a potential finding.

SBAG is concerned for the status of the Minor Planet Center, which is a unique and crucial facility for the small bodies community.

SBAG strongly supports the creation of a NASA Planetary Defense Coordination Office, a top recommendation of the NAC Task Force Report, and an idea supported by a recent Inspector General activity.

SBAG supports a reinstatement of OSIRIS-REx education programs, which recently incurred a loss of \$4M, within NASA's new educational policies and approaches. SBAG is concerned that the current SMD Science Education Cooperative Agreement Notice will risk losing these valuable Education and Public Outreach activities.

SBAG is concerned in general for technology development efforts that support PSD missions,

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such as long-term instrument survival in extreme or inhospitable conditions.

Other items of note include community work on the first SBAG Goals Document, which is expected to be finalized in February 2016. The document will focus on planetary defense, science, and human exploration. The next SBAG meeting is 29 June- 1 July, 2015 in Washington, DC (Asteroid Day is 30 June), followed by another in January 2016 in Orlando, FL. Dr. Chabot recommended some slides on Ceres, Pluto and NEAs on the SBAG website, and viewing the best-ever images of Pluto beginning in May.

### VEXAG

Dr. Glaze presented the latest VEXAG activities. The Venus Exploration Analysis Group (VEXAG) hasn't had a full meeting in over a year, and is finally meeting next week. The number-one issue on people's minds is the Discovery program. Now is the time for Venus, as there are no new missions in foreseeable future. Akatsuki will try to achieve orbit in September, but it will orbit not as originally planned, as its instruments have aged. ESA's M4 call has elected to include no planetary missions; a solar orbiter and exoplanet mission have been selected instead. ISRO has a concept study ongoing for a Venus mission (to be reported in February 2016). Venus is a key example of planetary exploration that is needed for comparative planetology. Concerns were raised about R&A selection rates during a Venus Town Hall at LPSC; Dr. Voytek spoke about the selection rate and judged it "about par" for the SSW program. There is continued concern about the low number of non-atmosphere Venus proposals submitted or selected, as well as concern about programmatic balance, and the lack of geology/geophysics overall in SSW. More communication may alleviate these concerns.

An Extreme Environments Centennial Challenge (EECC) has been announced, which will focus on long-term survival of instruments on the surface of hot planets, including high-temperature electronics. The solicitation for ideas in an October RFI has been developed, and should be released by Headquarters this Spring. The Point of Contact (POC) for the Challenge is Dr. Tibor Kremic at Glenn Research Center.

The Venus Gravity Assist Science Opportunity Panel has evaluated the paths of Solar Orbiter, Solar Probe Plus, and Bepi-Colombo, all of which have multiple flybys at Venus. The idea is to assess and identify unique science observations that can address high-priority VEXAG science goals and objectives. Relevant events and activities included a workshop in May 2014. A Discovery call in February contained 4 Venus proposals out of 28 submissions. Venus Express has completed its mission, and has completed its aerobraking campaign. It depleted its fuel in November and went silent in January. It is assumed that the spacecraft has descended onto the planet, marking the end of a 9-year mission. In other news, the Glenn Extreme Environments Chamber is now operational, and a Venus III Book is in preparation.

Science nuggets include an observation that ionization processes are similar on Venus and Mars (data from Venus Express); Venus's Y feature is seen as a wind-distorted wave; and maps of the dynamic Venus sub-cloud atmosphere have been made using ground-based observations. Dr. Chabot and Dr. Glaze agreed to work together on a technology development finding for PSS.

### *General Discussion on Community Comments*

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PSS discussed general concerns. Drs. House and Glaze reiterated concerns about Education and requested a briefing from NASA's Education office. Dr. Rall noted that the CAN is in progress, and that more than likely Education at NASA will turn into an institute model. Dr. Mainzer requested more information regarding how new missions would be incorporated into the framework. Dr. Luhmann added that the subject had arisen at the last Science Committee in January and recommended that people consult the online meeting minutes.

Dr. McSween asked how a request to MEPAG would be handled under the changed NAC infrastructure. Dr. Pratt observed that MEPAG is not disbanded; it can still formulate responses. Dr. Rall mentioned that APD AGs are chartered through program offices, and that MEPAG uses same model. Dr. Hertz has been pushing for this model to go forward for other divisions. Results are still to be determined. Dr. Pratt noted that the model has pluses and minuses: a recent MEPAG presentation had to endure a lot of vetting at NASA before it could be released. Dr. Rall added that the direction is clear: there is nothing below the subcommittee that can be NASA-supported. The question is whether self-organizing groups survive without NASA support. Dr. Mainzer suggested a finding on the value of AGs, and Dr. Chabot seconded the suggestion. Dr. Mainzer was tasked with the finding.

The subcommittee discussed an expansion of findings from OPAG on R&A and international collaboration, as well as power systems. An emphasis on solar power seems to have reduced the demand for Pu-238; therefore, the community must keep pressure on radioisotope production so that it remains sustainable for mission demands.

Dr. Glaze addressed the Discovery cadence issue, noting that there are funding realities to consider. Dr. Neal warned against pressure on the R&A budget that could result from such a request. Dr. McSween commented that 3 years is good, but 2 years is better; and that the Decadal Survey states that R&A is a higher priority than launch cadence. Dr. McCoy noted that it might be possible to make more than one selection out of Discovery if there is an opportunity to partner with HEOMD, for example. Dr. Luhmann suggested making a plug for a Participating Scientist/Guest Investigator program in Discovery, e.g. for Dawn. Dr. Mainzer led the draft-writing.

Dr. McSween recommended elevating the CAPTEM finding on sample preservation to the Science Committee's attention.

### PDS

Dr. New, Program Scientist for the Planetary Data System (PDS) presented a briefing on the PDS, NASA's active accumulating archive for data from NASA's Solar System missions. PDS is currently holding 700 TB of data that is accessible to anyone, online, with no password needed. PDS is a federated data system that presents a single interface to the Internet. Its current organizational structure is composed of discipline nodes (imaging, atmospheres, etc.) that talk directly to missions. There are technical support nodes at JPL and Ames Research Center. Project management support is carried out through a Chief Scientist, Radio Science Advisor and Change Control Board, thence to PDS Office, and then up to Headquarters. The PDS discipline nodes CAN establishes a network of organizations to serve as these discipline nodes. An active solicitation is now under way, with step-2 proposals due 1 June, selection in September, and

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awards 31 October. There are seven objectives to propose to, including planetary flight projects, data security, ingestion of new datasets, etc. Each proposal must use PDS core standards.

PDS-4 is the new standard for the system, representing the first upgrade to be made in about a decade. It is built on modern, web-based technology, such as XML, RDS, and JSON. The upgrade improves data ingestion, and access and support for international missions. The motivation for the upgrade was predicated on the growth of the PDS, as well as the fact that software, hardware, and tools have changed considerably over the last decade. All data will be tied to a common model, which helps to validate data. PDS is building a hierarchy of data dictionaries designed to the latest ISO standard, which will enable a distributed search infrastructure, or the “Netflix” of data distribution. Planned and current mission support has included the Lunar Atmosphere and Dust Environment Explorer (LADEE). PDS is now in the process of supporting MAVEN, and is planning to support InSIGHT and OSIRIS-REx, one of which downloads data in a unique format. PDS is also planning to support Bepi-Colombo and ExoMars. ISRO and JAXA also have plans to use PDS-4, which is designed to be a much more interactive archive in terms of international collaboration.

PDS has a new Chief Scientist, Dr. Ralph McNutt. As PDS has been criticized in the past for not focusing enough on data users, one of Dr. McNutt’s first tasks will be to resurrect the PDS Users Group to provide community input. In the meantime, PDS will be adding or expanding user workshops, exploring videotaping/webcasting, and encouraging the creation of more User’s Guides as part of a broader division effort. PDS is also considering soliciting for new guides for completed missions, and is developing a tool strategy for data ingesting, data management, and distribution, the latter of which is being developed in-house. Planetary Data, Archiving, Restoration and Tools (PDART), a new element introduced in ROSES 2014, is a program designed to enhance the value of the planetary archive.

The second Planetary Data Workshop will be held 8-11 June 2015 in Flagstaff, AZ. Dr. Horanyi commented that PDS is an incredible service, but that there is a problem for international contributions. Dr. New expressed awareness of this problem but commented that the issue was one for upper management. Asked if PDS could mirror international data, Dr. New explained that PDS does have an interface with an ESA archive, while most other space agencies have their own archives.

PSS established its next tentative meeting dates as: 2-3 June and early to mid-October 2015.

### *Discussion of Findings and Recommendations*

Dr. Rall announced that he was working on getting a Facebook page or Twitter feed to disseminate information more quickly. Dr. Voytek supported the idea of holding virtual Town Hall meetings on a regular schedule, have more NASA staff available to answer questions.

In discussing a finding on the value of the AGs, Dr. Chabot related content of a communication with Dr. Steve Squyres on the AG situation; i.e. he was determined to find a way to continue the AGs and had a good talk with Dr. Green on the subject. While the matter is still in flux, the objective of the restructuring was to protect the AGs from the onerous requirements of the Federal Advisory Committee Act (FACA); the outcome was clearly a function of unintended

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consequences. He couldn't make promises, but did want to have the AGs continue.

In wrapping up the R&A finding discussion, PSS requested data that details PSD funding by program, and selection rates by panel score, essentially more detailed information for the FY14 allotments to the various programs in R&A. Dr. McCoy suggested that a table of such information across PSD, not just SSW, would be helpful.

Dr. Neal suggested that PSS specify where it sends its findings and identify what action is required. Dr. McSween agreed that this could be a regular agenda item, to revisit findings from prior meetings. While all findings go to PSD, broader findings go to the Science Committee. PSS concurred that three findings should be raised to the Science Committee: Agency-level NEO focus; sample utilization policy; and international collaboration in missions.

Dr. McSween noted agenda items for the next meeting: revisiting findings; a briefing on the Education CAN (and any other SMD education efforts); written instructions on how to go forward with AG meetings; a tentative schedule for PSS meetings that runs through 2016. Dr. Rall agreed to look into an alternative ways to have ethics training for the subcommittee, such as Launchpad accounts. Dr. Horanyi recommended having an item about NASA facilities on the next meeting agenda.

Dr. McSween adjourned the meeting at 4:28 pm.

## **PSS FINDINGS – Spring 2015**

### ***Finding: Science Priorities for Mars Exploration Program***

PSS applauds the increasing connectivity between HEOMD and SMD, but PSD should advocate for its core science priorities identified in the Planetary Decadal Survey to be achieved in the anticipated mission architecture for Mars. Specifically, it is important to understand how steps towards successful sample return will be balanced with filling critical knowledge gaps, mapping resources, and technical demonstrations in preparation for humans at Mars.

### ***Finding: Sample Use Policy for Sample-Return Missions***

The Discovery and New Frontiers missions AO language stating that the mission plan “shall demonstrate that at least 75% of the returned sample shall be preserved for future studies” should apply to all sample return missions, robotic and human. Deviations from this policy must be justified (e.g. renewable sampling, planetary protection requirements). OSTP-mandated collection management policies for NASA collections should, at the subcollection level (e.g., Apollo samples, Stardust, future samples returned by a human mission), explicitly discuss balancing long-term sample preservation and usage.

### ***Finding: Need for an Agency-Level NEO Survey Mission***

Based on input from the community with NEO expertise, PSS reiterates its finding that the elevation of an NEO Space-Based Survey Mission to the level of an Agency priority, and the pursuit of its new start, are needed to advance NEO knowledge and essential for NASA's Asteroid Initiative. An advanced space-based survey optimized for finding and characterizing near-Earth objects (NEOs) would serve multiple Agency goals, consistent with NASA's Asteroid Initiative and Asteroid Grand Challenge. Specifically, a NEO survey telescope addresses 5 of the 10 priority questions listed in Table 3.1 of the Decadal Survey, such as "What solar system bodies endanger and what mechanisms shield Earth's biosphere?", and is identified on page 3-13 as the most expedient method for detecting NEOs for purposes of quantifying the impact hazard to Earth; numerous other examples can be identified in the Decadal Survey as well. Along with achieving the Planetary Decadal Survey science, such an asset would advance exploration, planetary defense, and resource utilization goals.

### ***Finding: Assessment of Reorganized R&A***

The PSS applauds the initiation of an NRC study on the reorganized PSD R&A structure's effectiveness in achieving programmatic goals. We encourage continuing and

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regular dialog with the planetary science community about the R&A reorganization. As part of this ongoing dialog with the community, the PSS requests, across the full range of R&A programs within PSD, selection statistics, release of titles and abstracts of selected proposals, total funding levels (\$) by program, selection rates by panel score for new program elements, and statistics on time required for determining selectable and selected proposals relative to proposal submission or review.

***Finding: Status of Lunar Reconnaissance Orbiter and Opportunity missions***

The PSS reiterates its support for the results of the most recent Planetary Mission Senior Review, which found that both Lunar Reconnaissance Orbiter and the Mars Exploration Rover Opportunity extended missions were highly ranked and remain uniquely valuable assets that continue to carry out high priority scientific investigations. We are concerned that the President's budget calls for their termination and we encourage NASA PSD to seek ways to continue the operation of these important planetary missions.

***Finding: Radioisotope Power Source***

The re-start of domestic production of Pu-238 is a significant achievement. In the near term there must be a focus on getting all steps of the production line working to generate fuel at a sustainable level that enables mission planning and development. Also important in the near term is publication of the Nuclear Power Assessment Study (NPAS) report. In the longer term, the PSS encourages continued PSD investment to build on MMRTG technology (to increase efficiency of Pu-238 usage and boost end-of-life mission power) and to pursue technology development for radioisotope thermoelectric generators and Stirling generators.

***Finding: Value of NASA Analysis/Assessment Groups***

The PSS is concerned that analysis/assessment groups (AGs) have recently been excluded from the NAC structure, leading to their possible dissolution. Maintaining the functionality of these valuable groups in some form that allows timely interaction with the greater scientific community is critical. The existing set of planetary AGs serve as a valuable means of obtaining community input and scientific expertise on key issues for the Planetary Science Division and HEOMD. Moreover, the AGs provide a forum for the scientific community to discuss issues and priorities directly with NASA in a timely fashion. The PSS finds that the AGs in their current form have provided critical feedback to NASA, including both PSD and HEOMD, on a wide range of issues such as the Asteroid Redirect Mission, Decadal Survey white papers, the development of mission announcements of opportunity, and the research and analysis reorganization.

### **Finding: Increase Launch Cadence of Discovery Missions to 24 Months**

Recent efforts to increase the cadence of Discovery calls to 36 months are greatly appreciated. The PSS finds that PSD should follow the Decadal Survey recommendations of prioritizing R&A followed by a return to the 24-month Discovery launch cadence. The Planetary Decadal Survey recommended the following prioritization of planetary science programs: research and analysis, followed by competed missions (with lower cost lines coming first), then flagships. The first decade of Discovery-class missions illustrates the benefits of having frequent calls, including providing a means of addressing new high-priority scientific topics, encouraging the development of new scientists with mission experience who can serve as PIs for larger missions, supporting focused investigations by the research community, and providing scientific data on a diverse set of bodies throughout the solar system.

### **Finding: Long-term Enabling Technology Development Efforts**

The PSS encourages the Planetary Science Division (PSD) to coordinate technology investments to ensure appropriate resources are available for both coordination and funding of identified technology gaps. The Space Technology Mission Directorate (STMD) has specific objectives for technology development that focus on priorities with relevance across directorates. The more specific PSD programs (e.g., PICASSO and MATISSE) are focused on developing instrument technologies. However, opportunities for development of the critical technologies needed to enable future planetary missions are lacking. Specific examples of technologies that fall in a gap between STMD and PSD include development of the increased efficiency Advanced Stirling Radioisotope Generator (ASRG) that will enable deep space exploration, high temperature/pressure thermal control and power technologies that enable long-term survival in the Venus surface environment, and submersible technologies that enable exploration of oceans on the icy satellites. The coordination and identification of needs for exploration and planetary science missions requires constant and proactive coordination between the “mission customers” and STMD, in addition to directorate-specific resources to address these gaps.

### **Finding: International Collaborations**

The PSS encourages NASA to consider innovative agency-level policies that enable collaborative international development for unique projects that are of high priority to both NASA and other agencies that would otherwise be out of reach for individual agencies. Projects like Cassini-Huygens have demonstrated that close international collaboration greatly increases mission capabilities, resources, and scientific achievements. Such cooperation could enable high-priority missions identified by the Planetary Decadal Survey that will not be able to go forward with NASA alone, for example flagship missions that were studied for Uranus, Venus, and Enceladus.



Planetary Science Subcommittee Meeting, March 30-31, 2015

Appendix A  
Attendees

*Subcommittee Members*

Janet Luhmann, **Chair, Planetary Science Subcommittee** (via Webex)  
Nancy Chabot, APL  
Nancy Chanover, New Mexico State University  
Lisa Gaddis, US Geological Survey  
Lori Glaze, NASA Goddard Space Flight Center  
Mihayi Horanyi, University of Colorado  
Christopher House, Pennsylvania State University  
Amy Mainzer, Jet Propulsion Laboratory  
Harry McSween, Acting Chair PSS, University of Tennessee  
Tim McCoy, Smithsonian Institution  
Clive R. Neal, University of Notre Dame  
Larry Nittler, Carnegie Institute  
Lisa M. Pratt, Indiana University  
Elizabeth Turtle, Applied Physics Laboratory  
Anne Verbiscer, University of Virginia  
**Jonathan Rall, Executive Secretary PSS, NASA HQ**

*NASA Attendees*

Max Bernstein, NASA HQ  
Doris Daou, NASA/SSERVI  
Kelly Fast, NASA HQ  
James Green, PSD, NASA HQ  
Jeff Grossman, NASA HQ  
Dave Lavery, NASA HQ  
Michael Meyer, NASA HQ  
Michael New, NASA HQ  
Sarah Noble, NASA  
Joan Salute, NASA HQ  
Mitch Schulte, NASA HQ  
Tom Statler, NASA HQ  
George Tahu, NASA HQ  
Mary Voytek, NASA HQ  
James Watzin, NASA HQ

*Other Attendees*

Francesco Bordi, Aerospace  
Steve Mackwell, USRA LPI  
Ana Wilson, Zantech IT  
Joan Zimmermann, Zantech IT

Planetary Science Subcommittee Meeting, March 30-31, 2015

Webex Attendees

B. Archinal, USGS  
Damaro Arrowood  
Neil Barberis, Raytheon  
Louis Barbier  
Janice Buckner, NASA  
Julie Castillo, NASA JPL  
Nicola Dauphas, U Chicago  
James Dean, Florida Today  
Brett Deneri, JHU APL  
Lamont DiBiasi  
Serena Diniega, NASA JPL  
Dave Draper, NASA  
Casey Dreier  
David Eisenman, NASA JPL  
Walt Falconer, Strategic Space Solutions  
Andrew Follett  
James Gaier, NASA  
Mark Gurwell, Harvard U  
Shawn Goldman, NASA  
Tommy Grav  
Ryan Green  
Jeffery Hollingsworth, NASA  
Michael Kelley, NASA  
Dan Leone, Space News  
Samuel Lawrence, ASU  
Alfred McEwen  
Chase Million  
Michael Nolan, NAIC  
DA Papanastassiou  
Daniel Peters  
Betsy Pugel, NASA  
Christian Rice  
James Roberts, JHU APL  
Dan Scheld, NSCI  
Margaret Simon, JHU APL  
Jim Skinner, USGS  
Mike Skrutskie  
Marcia Smith  
Amber Story  
Tom Sutliff, NASA  
Steve Vance, JHU APL  
Dan Vergano  
Richard Vondrak, NASA  
Alexandra Witze  
Rich Zurek, NASA JPL

Planetary Science Subcommittee Meeting, March 30-31, 2015

Appendix B  
Membership Roster  
Planetary Science Subcommittee

Janet Luhmann, Chair  
University of California, Berkeley

Nancy Chabot  
The John Hopkins University  
Applied Physics Laboratory

Nancy Chanover  
New Mexico State University  
Astronomy Department

David Draper  
NASA Johnson Space Center

Lisa Gaddis  
U.S. Geological Survey  
Astrogeology Science Center

Lori Glaze  
NASA Goddard Space Flight Center

Candy Hansen  
Planetary Science Institute

Mihaly Horanyi  
University of Colorado  
Laboratory for Atmospheric and Space Physics

Christopher House  
Pennsylvania State University  
Department of Geosciences

Amy Mainzer  
Jet Propulsion Laboratory

Timothy J. McCoy  
Smithsonian National Museum of Natural History

Planetary Science Subcommittee Meeting, March 30-31, 2015

Harry McSween  
University of Tennessee  
Department of Earth and Planetary Sciences

Clive Neal  
University of Notre Dame

Larry Nittler  
Carnegie Institution of Washington

Lisa M. Pratt  
Indiana University

Anne Verbiscer  
University of Virginia

Jonathan Rall  
Executive Secretary  
NASA Headquarters  
Science Mission Directorate: Planetary Science Division

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Appendix C  
*List of Presentation Materials*

1. Planetary Science Division Status and Findings Update; *James Green*
2. Planetary Science Division Research and Analysis, and Findings Update; *Jonathan Rall*
3. Mars Exploration Program and 2020 Update; *James Watzin*
4. NASA Advisory Structure and Process (AGs); *James Green*
5. Community Comments: CAPTEM; *Harry McSween*
6. Community Comments: LEAG; *Clive Neal*
7. Community Comments: MEPAG; *Lisa Pratt*
8. Community Comments: OPAG; *Elizabeth Turtle*
9. Community Comments: SBAG; *Nancy Chabot*
10. Community Comments: VEXAG; *Lori Glaze*
11. Planetary Data System; *Michael New*

Appendix D  
Agenda

**Planetary Science Subcommittee Meeting**

March 30-31, 2015

NASA Headquarters

Washington D.C.

Monday, March 30, 10:00 a.m. – 5:00 p.m. (5H41A)

10:00

Welcome, Agenda, Announcements .....(H. McSween, J. Green, J. Rall)

10:30

PSD Status & Findings Update ..... (J. Green)

12:00 Lunch

1:00 PSD R&A & Findings Update .....(J. Rall)

2:00 Mars Exploration Program + Mars 2020 Update .....(J. Watzin)

3:00 Break

3:15 NASA Advisory Structure and Process .....(J. Green)

4:15 Discussion .....(All)

5:00 Adjourn

Planetary Science Subcommittee Meeting, March 30-31, 2015

Tuesday, March 31, 8:30 a.m. - 5:00 p.m.  
(5H41A)

- 8:30 Agenda Updates & Announcements .....(H. McSween, J. Rall)
- 9:00 Community Comments: CAPTEM ..... (H. McSween)
- 9:20 Community Comments: LEAG .....(C. Neal)
- 9:40 Community Comments: MEPAG .....(L. Pratt)
- 10:00 Break
- 10:20 Community Comments: OPAG .....(E. Turtle)
- 10:40 Community Comments: SBAG .....(N. Chabot)
- 11:00 Community Comments: VEXAG .....(L. Glaze)
- 11:20 Discussion .....(All)
- 12:00 Lunch
- 1:00 PDS .....(M. New)
- 2:00 Q&A Session with the Committee .....(All)
- 3:00 Break
- 3:15 Findings and Recommendations Discussions..... (All)
- 5:00 Adjourn

***Teleconference Information:***

**Toll free conference call number 844-467-4685 Pass code: 863162#**

***WebEx Link:***

**<https://nasa.webex.com/>**

**Meeting number for March 30 394 353 454 Password: PSS@Mar30**

**Meeting number for March 31 390 606 220 Password: PSS@Mar31**