

OPAG Findings (Spring 2019)
July 3, 2019

1. Transparency on ICEMAG Termination Process

OPAG thanks NASA for the response to the Special OPAG Finding on the cancellation of the ICEMAG investigation. NASA explained that the process of the ICEMAG termination was a consequence of projected cost overruns. However, OPAG finds that, as a consequence of inadequate transparency on the process, the community is still left uninformed of when and how the termination process is applied.

Termination of a PI-led flight investigation is an extremely serious matter to the entire space science community. At the last OPAG meeting, it was stated that the ICEMAG termination process would serve as a precedent for similar reviews of PI-led SMD missions and instruments in the future. OPAG believes that NASA should ensure that future executions of instrument termination decisions should follow a transparent, standardized procedure agreed to by all stakeholders.

OPAG is aware that the termination procedure applied to ICEMAG has been presented to the Europa Clipper leadership group. NASA has also presented the process to the National Academy of Science Committee on Astrobiology and Planetary Science (CAPS). OPAG believes that further efforts to raise the transparency of the process are needed.

Finding 1.

OPAG invites NASA to further engage the community to raise the transparency on the ICEMAG termination process at the next OPAG meeting. In particular, we suggest that NASA present to OPAG the termination rules-and-procedure briefing that was given to the Europa Clipper leadership group, and inform us how the ICEMAG termination process is being reviewed and what lessons have been learned.

2. Implication of On-Going Federal Budget Process to the Next Decadal Survey

The OPAG community is eager to contribute to the formulation of science priorities for the next decade. However, at the last OPAG meeting, concerns were raised about the President's 2020 budget proposal, which includes a new start for Mars Sample Return (MSR). The development concerns OPAG because, if such a new start becomes law, it may mean that the next large directed mission (or two) are decided before the Decadal process even begins, and NASA budget in the next decade may not allow implementation of additional Flagship missions that may be recommended by the next Decadal Survey. OPAG is concerned that on-going federal budget processes could render the next Decadal Survey irrelevant to decisions about upcoming large directed missions.

The Decadal Survey Vision & Voyages was very clear that the MSR Lander and Orbiter are deferred high-priority missions, not recommended for the decade 2013-2022. It says this in multiple places, but in most detail on pages 275-276. V&V did recommend focused technology development for MSR in the current decade, but explicitly stated that the MSR Lander and Orbiter missions were not recommended for this decade.

Finding 2.

OPAG requests NASA to explain the implications of a potential new start for Mars Sample Return for the next Decadal Survey.

3. Process for Future Mission Funding Termination

In a special OPAG finding (March 2019), following the abrupt mid-year cut to the final year of the Cassini budget, OPAG encouraged NASA to provide sufficient transition funding to support adequate mission closeout. This additional funding would also provide a smooth transition process to minimize the impact on young scientists and other investigators who were disproportionately affected by this cut. However, given the final budget reduction, these steps could only be partially realized.

Prior to the cut in the Cassini budget, no clear process was elucidated or discussed for making this cut. The value and impact of the science loss to NASA was not discussed. Abrupt funding cuts have important ramifications that should be considered, including the value of lost mission science and science data products, the time-lag involved in setting up multiple new contracts with science team members, and providing time to those affected to find other sources of funding. Good communication and discussion are important aspects of the development and implementation of major funding descopes within a project.

Finding 3.

OPAG requests NASA to develop and publicly share a clear process for terminating mission funding that involves time for collaborative, thoughtful discussions between the project and NASA HQ before final decisions are made. This process should include an evaluation of lost science and the development of a smooth transition plan. This plan should strive to minimize science loss, impact on young scientists, and loss of critical science data products.

4. Decadal Survey Organization and Statement of Task

OPAG recognizes the importance of the Statement of Task that starts the next Planetary Science Decadal Survey process. As the Decadal Survey will determine the direction of the planetary science investigations for the next decade, the OPAG community would like the opportunity to provide feedback before the Statement is finalized. Transparency in this process will help to engage and inform our community, and can help ensure that the Survey provides maximum value to NASA.

The Statement of Task lays the basic foundation of the Survey process. The last Survey's scientific scope was largely defined by the target bodies when the scope was framed in the Statement of Task as:

The scientific scope of the survey and report shall encompass the inner planets (Mercury, Venus, and Mars), the Earth's Moon, major planets (Jupiter, Saturn, Uranus, and Neptune), the moons of the major planets, dwarf planets and small bodies, primitive bodies including comets and Kuiper Belt objects, and astrobiology.

As written, astrobiology was an exception in that it was singled out as the sole process in the scientific scope. This Statement of Task led to the panel structure that divided the field by the target bodies, and astrobiology was represented in the process by including an astrobiologist in each of the target panels.

We believe that an unintended consequence of defining the scope only by the targets and not by the processes/workings was the weakened comparative planetology focus in the last Decadal Survey, including that in astrobiology. As the OPAG community covers many planetary destinations, a comparative planetology approach to assess the value of exploration based on processes/workings would allow science-based prioritization of the destinations. The next Decadal Survey could be strengthened by encouraging comparative planetology and prioritization among planetary destinations by defining the scope in terms of processes such as astrobiology, atmospheric science, geology, geophysics, solar wind interactions/magnetospheres and solar system origin/evolution to advance each topic in the comparative planetology context instead of defining the scope solely by target bodies.

Finding 4.

OPAG requests that NASA involve members of the planetary science community in the formulation of the Decadal Survey Statement of Task, and provide opportunities for the community to give feedbacks about the Statement before the Statement is finalized.

OPAG also encourages NASA to define the scope of the Survey by explicitly including processes/workings to ensure that the important goal of comparative planetology is accomplished.

5. Selection rate of Juno Participating Science Program (PSP)

OPAG commends NASA for the 3 Juno PSP proposals selected; however, approximately 7-10 PSP selections were anticipated from the call. Given that there were more selectable proposals submitted, OPAG requests clarification on why more of these selectable proposals were not funded. There is likely to be only one round of calls for Participating Scientist (PS) proposals for Juno, given the expected duration of this mission. Since PS programs are also crucial to the development of and enhancing diversity in the community (cf. Prockter et al., 2017) for a mission this large and important to the OPAG community, OPAG encourages a larger number of PS selections from this year's selectable pool.

Finding 5.

- 1. Given that about 10 Juno PS proposals were selectable, OPAG requests the timely selection of additional Juno PS proposals from those that were considered selectable by the review panel.**
- 2. OPAG requests insight into where the additional funds allocated for the Juno PS program were used (were the funds given to the Juno mission for instance, or used for some other program?)**
- 3. Given the Juno PSP experience, OPAG requests NASA to review the PS process, from the draft AO through selection, to improve the implementation of the PS process in general, including a timelier PS announcement after the proposal review process. Some key items for consideration include involving the project in identifying specific investigations to list in the AO that would enhance the mission science.**

6. Opening the New Frontiers Program

NASA should consider opening the New Frontiers program to all concepts addressing high-priority science questions from the Decadal Survey. This was partially implemented for NF-4, resulting in selection of the innovative *Dragonfly* mission to Titan. The New Frontiers program should be adaptable to new discoveries as well as major scientific and technological developments made since the Decadal Survey was written. New Frontiers missions should provide the potential to significantly advance the fundamental scientific goals of the Decadal Survey by answering high-priority science questions from the Decadal Survey, and should accomplish scientific investigations that are well beyond the scope of the smaller Discovery Program. As of this date several other NASA Assessment Groups are now advocating for just such an opening of the New Frontiers Program.

Finding 6.

OPAG joins several other NASA Assessment Groups in strongly advocating that NASA open the New Frontiers program to all mission concepts that address high-priority science questions from the Decadal Survey in time for the NF5 call.

7. Supporting New Planetary Protection requirements relevant for Ocean Worlds

OPAG commends the progress made in the recent Europa Clipper Planetary Protection Workshop, which defined much needed specific requirements based upon science results and established techniques, including a 1000-year period of biological exploration, and 2.5 Mrad TID as sterilization equivalence. Meetings such as this that engage a broad swath of experts, including those that specialize in planetary science and those that specialize in microbiology and PP technology provide a road map for future progress in this area. We commend the Planetary Protection Office for its commitment to establishing best practices when the probability of contamination meets requirements, and its efforts to improve the techniques used in sterilization. These are critical steps forward that will have a profound influence on the development of mission concepts, and pave the way for future Ocean Worlds landers such as a lander for Europa. OPAG is also supportive of the Planetary Protection Independent Review Board (PPIRB), recently established to review current PP guidelines and recommend any updates that are required. As we begin to work towards in situ life detection missions, OPAG encourages NASA to continue developing a process for defining PP requirements with scientific community input in order to best balance PP approach and specific science requirements. We support engaging a process that takes advantage of modern biological techniques, such as DNA sequencing, alongside best practices from other areas of research that face similar challenges, such as food safety.

Finding 7.

OPAG supports the early definition of Planetary Protection requirements for future outer planets missions, in particular those that will study Ocean Worlds, and encourages the Planetary Protection Office to establish a process that engages the science community in the definition of PP standards and bioburden and other risk assessments in order to enable the search for life in our solar system.

8. Mission Team Workplace Environments

OPAG thanks NASA for responding to the special OPAG finding on the cancellation of the ICEMAG investigation. OPAG remains concerned that NASA's public response to this finding did not adequately address the following important point in the finding:

"... OPAG wishes to express the community's shock over this decision. To those not involved in the process, this news came as a complete surprise. An important aspect of the community's reaction is the perception of unfairness in the process. Recent social scientific research shows that members of underrepresented groups, including women, are subjected to overly harsh consequences when not meeting expectations (e.g., Rudman & Phelan, 2008; Dovidio & Gaertner, 2000). We encourage NASA to ensure that this or any other termination decision is transparent, and avoid the perception that this PI-led experiment team received a seemingly punitive decision that is disproportionate to the challenges faced by the team."

The ICEMAG termination is an example of a public action by NASA that generated negative community perception, and had an adverse impact on the community climate. OPAG suspects that other less public factors may also impact the workplace environment and climate, putting the success of missions at risk. Such factors can be effectively learned and monitored by a professionally administered workplace climate survey. The importance of understanding the impacts of the ICEMAG termination process on the science team makes the need for a workplace climate survey particularly urgent.

Finding 8.

OPAG requests that NASA commissions a professionally conducted workplace climate survey for the Europa Clipper Project within the next six months, and periodically conduct surveys for each of the other NASA planetary science mission projects to monitor the workplace environment. NASA should use the survey to identify and quickly address workplace climate issues to reduce risk to

mission success, improve the mission team workplace environments, and identify and replicate best practices.

9. Diversity in NASA Planetary Science Workforce

At the April 2019 OPAG Meeting, Dr. Julie Rathbun presented on the importance of Equity, Diversity and Inclusion (EDI) in the planetary science community, and discussed how EDI practices must be implemented in order to broaden participation in the planetary science workforce. Dr. Rathbun discussed that, although significant progress has been made in women's participation in planetary science, the 2011 planetary science demographic survey indicated that women are underrepresented, and account for only 25% of the workforce. Dr. Rathbun also emphasized the importance of focusing on multiple axes of diversity, and noted that racial minorities are the most underrepresented group in the planetary science workforce, with African American, Indigenous, and Latinx scientists each making up no more than 5% of the planetary science workforce. Dr. Rathbun's presentation can be reviewed on the OPAG meeting archive (<https://www.lpi.usra.edu/opag/meetings/apr2019/presentations/Rathbun.pdf>). Dr. Rathbun encouraged OPAG to continue the discussion of EDI at all future OPAG meetings, recommended that EDI in the planetary science workforce be considered in the Decadal Survey, and that NASA fund EDI research in order to ensure the long-term health of the planetary science community.

Finding 9.

OPAG thanks NASA for supporting Dr. Rathbun's work on EDI, and requests NASA to implement the following:

- 1. OPAG urges NASA to continue to make resources and funding available in the upcoming fiscal years to study barriers to participation in the planetary science workforce.**
- 2. OPAG encourages inclusion of EDI as a study topic in the upcoming Planetary Science Decadal Survey.**
- 3. OPAG urges NASA to continue their efforts to enhance workforce diversity along multiple axes. These efforts should include, but are not limited to, initiatives that support gender diversity, and establish programs to broaden participation of ethnic and racial minorities who are extremely underrepresented in NASA-funded science communities and in the planetary science workforce.**

10. Expansion of Cassini Data Analysis Program

The Cassini Data Analysis Program (CDAP) is an important source of support to the OPAG community. This program is vital for enhancing the science return of the Cassini mission by funding research from the entire community. In addition, with the abrupt end in Cassini funding, CDAP becomes an important source of funding to support the development and archiving of the most critical Cassini higher-order data products.

The latest number of CDAP Step-1 submittals was about the same as last year, but these numbers may underestimate the actual demand for CDAP funding. The timing of Cassini funding cuts, including the time needed for the project to generate new budget allocations, and the due dates for CDAP were too close together for many Cassini scientists to prepare and submit credible, well thought out CDAP proposals this year. NASA should not use the latest number of submittals to suggest a reduced demand. Next year's CDAP numbers will be a better indicator of the real demand on CDAP funds after the end of Cassini funding.

Finding 10.

OPAG applauds the spectacular success of the Cassini mission at Saturn and asks NASA to adequately support and increase CDAP funding to ensure optimum science output from this mission. In addition:

- 1. In the coming years, augmentation in the CDAP budget is needed to take full advantage of the rich, high science-value data set returned by the Cassini mission and to prepare for future outer planet missions, especially those to the Saturn system. CDAP funding is especially needed for the development and archiving of critical higher-order science and engineering data products, specifically those related to the final year of the mission, which will aid future scientists in the analysis of Cassini data.**
- 2. Cassini, with its 13 years of archived Saturn system data, should have a continued dedicated data analysis program for many years to come, helping to bridge the large gap before the next large Outer Solar System mission and ensuring that a knowledgeable cadre of outer planet scientists will be ready to analyze data from the Europa Clipper mission, as well as other future outer planet missions.**

11. Europa Clipper Progress

The full success of Europa Clipper remains a top priority of OPAG. OPAG heard updates from the Europa Clipper project, which had its Preliminary Design Review (PDR) in August, 2018, and the team has since worked to reduce cost risk in multiple areas. The project underwent delta-PDR in mid-June, which is a critical step toward mission confirmation. Three of the Europa Clipper instruments have already undergone and passed their Critical Design Review (CDR).

Finding 11.

OPAG advocates maintaining the robust and synergistic scientific payload of the Europa Clipper Mission. NASA should ensure that scientific priorities drive any decisions that might affect the payload complement and its functionality. OPAG continues to support the earliest feasible arrival date for Europa Clipper, to ensure a healthy Outer Planets program. OPAG encourages NASA to add a gravity science team to the mission, to ensure success in achieving this top-level priority to confirm and understand the ocean.

12. Ocean Worlds Exploration

The 2016 Congressional Commerce, Justice, Science, and Related Agencies Appropriations Bill directed NASA to create an Ocean Worlds Exploration program, using a mix of programs already funded within NASA. Their direction for this program was to seek out and discover extant life in habitable worlds in the Solar System. In support of these efforts, the Outer Planets Assessment Group (OPAG), with cooperation from NASA's Planetary Science Division, formed the Roadmaps to Ocean Worlds (ROW) group to assemble the scientific framework guiding the exploration of Ocean Worlds. The ROW group assembled a Goals, Objectives and Investigations document along with a Priorities, Mission Scenarios and Technology document (both posted on the OPAG webpage). The ROW group published a paper in Astrobiology (Hendrix et al., 2018) summarizing the results of the ROW community study. To follow on to these efforts, a reasonable next step is a National Academies study.

Finding 12.

OPAG would like NASA to request that the National Academies assess the science value of an Ocean Worlds exploration program and how it fits in with broader solar system exploration. This

NAS assessment, provided as input at the start of the Planetary Decadal Survey process, will allow the Survey panels to consider the results as part of their deliberations.

13. Mission to an Ice Giant System

The Ice Giants remain the top priority Flagship target for OPAG, after the launch of Europa Clipper. The broad range of science to be done at one or both Ice Giant systems will address major science objectives of the Planetary and Exoplanet communities. OPAG is encouraged by the on-going discussions between NASA and ESA about a joint mission. The conclusions of the recent ESA study resonate with NASA's own study results, and the sense of OPAG, that a well-instrumented orbiter mission to study at least one of the systems is necessary, that it should carry an atmospheric entry probe, and that options for exploring both Uranus and Neptune should be considered.

Both NASA and ESA studies also find optimal launch windows for Neptune occur in the late 2020's and for Uranus in the early 2030's. Advanced work on an Ice Giant mission should begin now to meet those launch windows. We note that beginning work on an Ice Giant mission this decade is consistent with the Vision and Voyages Decadal Survey for the period 2013-2022. OPAG also emphasizes that, while Uranus and Neptune are equally compelling targets, because of the Ocean Worlds community's interest in Triton, Neptune is OPAG's preferred target.

While an Ice Giant mission can be achieved with current or in-development technologies, OPAG notes that technology developments offer greatly increased science return. It is crucial to complete development of HEEET material for an atmospheric entry probe's thermal protection system. Due to its expected significant specific power increase compared to the eMMRTG used for the 2017 pre-decadal mission study, a next generation Radioisotope Power System (RPS) has the potential to tremendously enhance the science return. Demonstrating aerocapture techniques also has the potential to enhance Ice Giant missions, particularly at Neptune, by increasing the mass delivered to orbit.

Finding 13.

OPAG strongly supports an Ice Giant System Flagship mission as the scientifically compelling, next logical directed mission after Europa Clipper. OPAG prioritizes the Neptune system as the mission's target, and finds there is a need to begin work prior to 2020 due to trajectory concerns for reaching Neptune that require a launch date in the late 2020's. OPAG encourages NASA to rapidly advance its discussions with ESA so that a high-level mission architecture and target can be selected. OPAG also encourages continued, rapid advancement of HEEET and next generation RPS technologies, and maturation of aerocapture techniques, as these can significantly enhance the science return of an ice giant mission.