MExAG

MExAG
Mercury Exploration Assessment Group

23 November 2020

Notes from the Mercury Exploration Assessment Group

- 1st MExAG Annual Meeting will be 3–5 February 2021.
  - Initiation of development of MExAG Goals Document.
- Completion and adoption of MExAG Steering Committee Code of Conduct expected by end of 2020.
- BepiColombo had a successful 1st flyby of Venus – has a 2nd Venus flyby Aug 2021 and 1st Mercury flyby Oct 2021.
- The Mercury community is examining the NF-5 major parameters announcement.
  - It has been noted that the proposed cost cap represents a significant cut from NF-4 and when inflated to FY25$ is significantly smaller than PMCS project guidelines.

Mercury and the Decadal Survey

- 6 Mercury presentations were made to the Decadal Survey Panel on Mercury and the Moon
  - *Science Goals and Current Status of BepiColombo* – Johannes Benkhoff (ESA)
  - *Priorities of the Mercury Exploration Assessment Group* – Steven Hauck (CWRU)
  - *Mercury Sample Return and Related Research and Analysis Activities* – Kathleen Vander Kaaden (Jacobs/JSC)
  - *Mercury Polar Volatiles* – Ariel Deutsch (ARC)
  - *Mercury Lander Mission Concept* – Carolyn Ernst (JHU-APL)
  - *Goals for the Study of Mercury's Magnetosphere and Exosphere* – James Slavin (Michigan)

VEXAG

VEXAG Update
November 23, 2020

VENUS EXPLORATION VEXAG ANALYSIS GROUP

Darby Dyar (PSI, Mount Holyoke College), Chair
Noam Izenberg (Applied Physics Laboratory), Deputy
Giada Arney (NASA GSFC), Early-Career Representative
Jeff Balcerski (Ohio Aerospace Institute)
Paul Byrne (North Carolina State University), Early-Career Representative
Candace Gray (NM State University) Early-Career Representative
Natasha Johnson (NASA GSFC)
Stephen Kane (University of California at Riverside)
Pat McGovern (Lunar & Planetary Institute)
Joseph O'Rourke (ASU), Early-Career Representative
Emilie Royer (University of Colorado)
Jennifer Whitten (Tulane), Early-Career Representative
Colin Wilson (University of Oxford)
Tommy Thompson (JPL), Scribe

Megan Ansdell (NASA HQ) ex officio

VENUS
THE ORIGINAL OCEAN WORLD

VEXAG is excited about and inspired by the growing public interest in Venus exploration, spurred by phosphine discovery, water on surface for 3 BY, and other recent work…

ASTRONOMY

Forget Mars, a startling discovery may mean there's life on Venus

By David Woode

Alien life could be thriving in the clouds above Venus: a team of astronomers detected a rare gas in its atmosphere, according to a study involving British researchers.

Venus, the second planet from the Sun, has a surface temperature of 500°C, and 96 per cent of its atmosphere is composed of carbon dioxide. But the discovery of phosphine, around 31 miles (50km) from the planet's surface, has indicated that life could prosper in a less hostile environment.

On Earth phosphine – a molecule of one phosphorus atom and three hydrogen atoms – is associated with life. It is found in places that have little oxygen, such as swamps, or with microbes living in the guts of animals.

A group of British, American and Japanese scientists – led by Jane Greaves from Cardiff University – first identified Venus's phosphine using the James Clerk Maxwell Telescope in Hawaii. The presence of the gas was confirmed at an astronomical observatory of 45 telescopes in Chile. The discovery was published yesterday in the journal *Nature Astronomy*.

Professor Greaves said: "This was an experiment made out of pure curiosity. I thought we'd just be able to rule out extreme scenarios, like the clouds being stuffed full of organisms. When we got the first hints of phosphine in Venus's spectrum, it was a shock." Dr Emily Drabek-Maunder, a Royal Greenwich Observatory astronomer who was part of the research team, added: "This was an incredibly difficult observation to make. We still have a long way to go before we can confirm how this gas is being produced but it is definitely an exciting time for science."

The team is now awaiting more telescope time to establish whether the phosphine is in a particular part of the clouds, and to look for other gases associated with life. While the clouds above Venus have temperatures of around 30°C, they are made from 90 per cent sulphuric acid – a major issue for the survival of microbes.

Professor Emma Bunce, president of the Royal Astronomical Society, has called for a new mission to Venus to investigate the findings.

SCIENCE

Nothing found since claims awed Clinton

By David Woode

In August 1996, President Bill Clinton legitimised the search for alien life in space when scientists claimed they had found evidence for microscopic fossils of bacteria in a meteorite, suggesting that they originated on Mars.

The president hailed the discovery saying: "If this is confirmed, it will surely be one of the most stunning insights into our universe that science has ever uncovered. Its implications are as far-reaching and awe-inspiring as can be imagined."

Confirmation of even microbial life on Mars is still awaited. Nonetheless, the speech was deemed groundbreaking, for it was the first time a sitting president had used an executive office forum to discuss alien life. Since then, researchers around the world have searched for life on Mars Last year a scientist at the University of Edinburgh examined ancient rocks on Earth to distinguish between fossils and non-biological structures.

More than 4,000 exoplanets have now been identified. A handful are thought to have the potential to harbour life but confirmation is lacking.

Other potential signs of life that have been sought include radio messages from space. As yet, none have been picked up.

Venus has a surface temperature of 500°C. Left: a representation of phosphine molecules in the clouds above the planet REUTERS, AFP/GETTY

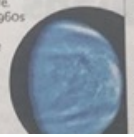
Earth's sister planet

Venus is the second planet from the Sun and the second-brightest natural object in the night sky after the Moon.

As the planet with the closest approach to Earth, Venus was of interest for early interplanetary exploration.

In the first half of the 20th century it was thought by many to be the place most likely to find extraterrestrial life. However, by the 1960s and with greater observation of the planet, scientists had discovered just how inhospitable it is.

It has the



SCIENCE

Second quake shakes Leighton Buzzard homes

By Alistair Mason

A second earthquake in the space of a week has struck Leighton Buzzard (*inset*), according to the British Geological Survey (BGS).

The tremor in Bedfordshire, at 11.20pm on Sunday night, was measured by the BGS at magnitude

REACTION

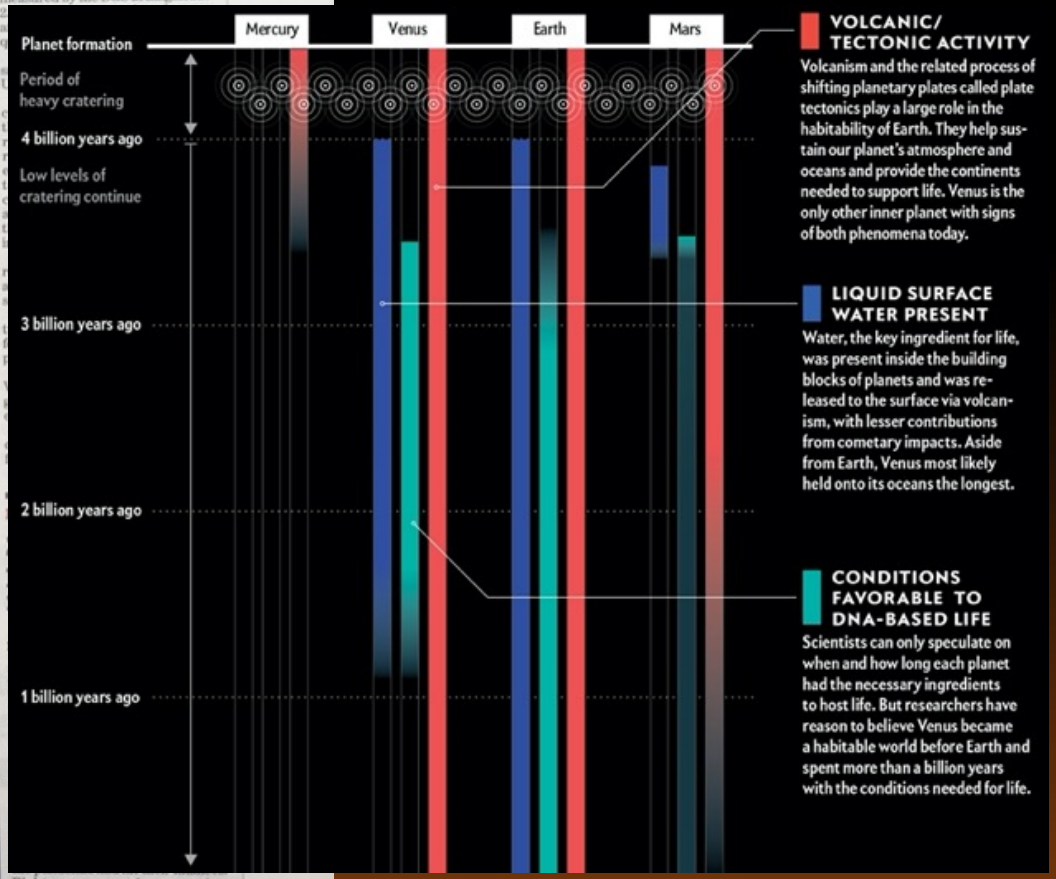
Headline 18 one sheep mfd gfdg dfostly s

By Jane Clinton

should expect it in a much wider

and lead to new discoveries. He

Eighteen per cent have opted to



VEXAG Re-Organization Continues…

1. Organization structure codified
2. Committee structure to support inter-AG biannual meeting (e.g., Exoplanets in our Backyard)
3. Reviewing and revising Venus Gravity Assist Science Opportunities
4. Venus Science nuggets flowing to NASA HQ, posted in VEXAG site
5. Reorganization of VEXAG site at LPI
6. Ongoing support of Venus Surface Platform Study, nearly complete
7. Creating community-maintained database of tools and technology for Venus studies and exploration
8. Piloting public outreach talks about Venus streamed from and archived on You-Tube; potential to reach 30,000-60,000 people!

VEXAG Activities

- Annual meeting (virtual) held November 16/17: 53 abstracts from 8 countries, 295 registrants from 25 countries. We had >9 hours of presentations, including lighting talks for posters and panels with 4 speakers/each + discussions
- Submitted our strategic documents for publication in Planetary Science Reviews
- 67 Venus-focused or Venus-related white papers submitted to the Decadal Survey
- Provided input to New Frontiers 5 AO
- Represented on committees:
  - AG Chairs caucus
  - NExSS, Nexus for Exoplanet System Science
  - ExoPAG Science Interest Group
  - Equity, Diversity, and Inclusion Working Group

LEAG

LEAG Executive Committee

Chair, LEAG	Dr. Amy Fagan, *Western Carolina Univ.*
Emeritus Chair	Dr. Samuel Lawrence, *NASA JSC*
Science Chair	Dr. Brett Denevi, *Johns Hopkins Univ. APL*
Human Exploration Chair	Dr. Kelsey Young, *NASA GSFC*
Technology Chair	Dr. Jose Hurtado, *Univ. of Texas, El Paso*
Operations Chair	Dr. Erica Jawin, *Smithsonian Institution*
Strategic Policy Chair	Dr. Lisa Gaddis, *Lunar and Planetary Institute*
Early Career Representative	Dr. Sarah Valencia, *NASA GSFC/ Univ. Maryland*
Equity, Diversity, & Inclusion Chair	Dr. Kristen Bennett, *USGS*
Astrophysics Community Liaison	Dr. Alexander Hegedus, *Univ. of Michigan*
Member-at-large	Dr. Ryan Watkins, *Planetary Science Institute*
Member-at-large	Dr. Benjamin Greenhagen, *Johns Hopkins Univ. APL*
Chair, Commercial Advisory Board	Dr. Elizabeth Frank, First Mode Inc.

Ex Officio Members:

NASA-SMD, PSD	Dr. Sarah Noble
NASA-HEOMD	Dr. Jacob Bleacher
NASA-STMD	Dr. Andrew Petro
SSERVI	Dr. Greg Schmidt

LEAG Activities since August

- Formal collaboration with Lunar Surface Innovation Consortium (LSIC) governing body (September 2020)
  - Established LEAG Technology Chair, Dr. Hose Hurtado as formal LEAG representative
- LEAG annual meeting (14-16 September 2020): ***The Value of a Sustained Human Presence at the Artemis Base Camp***
  - 22 Community findings
- Artemis III Science Definition Team
  - Executive Committee, several community members, and other community groups (CAPTEM, SSERVI PI's) targeted for direct input of priorities (September and October 2020)
  - Joint LEAG/SSERVI Town Hall (22 October 2020) for broader community input
- Decadal Survey
  - 4 Official LEAG White Papers submitted
  - LEAG Chair presented LEAG Goals and Priorities to Subpanel for Mercury and the Moon (20 November, 2020)
- **Upcoming**: Making preliminary plans with SSERVI to host joint Town Hall regarding New Frontiers 5 (January 2021)

Full Findings on the LEAG website: *https://www.lpi.usra.edu/leag/*

Findings Topics from Annual LEAG Meeting

1) Artemis Program

- Increase sample return mass and crew time
- Mobility
- Communication
- Support for Artemis III Science Definition Team, Artemis Base Camp, Lunar Surface Science Workshops
- Request more information about flight cadence; plans for Artemis Base Camp; timing of delivery of planned lunar surface assets and ISRU capability

2) Sustainable Exploration of the Moon and Beyond

- Studies on the lunar surface to advance capabilities and technologies
- Value innovative approaches to getting payloads to surface (LDEP and CLPS)
- Coordination and Collaboration: form an Integrated lunar office; international partnerships; commercial partnerships
- Applaud: LSIC, VIPER
- Long-term orbital strategy (next gen LRO)

3) Diversity, Equity, Inclusion, and Accessibility

- Include diversity, equity, and inclusion in all aspects of our work and community
- Robust and sustainable R&A funding
- Virtual meetings enable accessibility

4) Commercial Advisory Board

- CAB supports increasing opportunities for commercial involvement

Official LEAG Decadal Survey White Papers

- The Importance of Human Exploration in Accomplishing High Priority Lunar Science Objectives
  - Lead Author: Dr. Kelsey Young
- Lunar Missions for the Decade 2023-2033
  - Lead Author: Dr. Barbara Cohen
- Planetary Science Priorities for the Moon in the Decade 2023-2032: Lunar Science is Planetary Science
  - Lead Author: Dr. Erica Jawin
- The Moon is a Special Place
  - Lead Author: Dr. Daniel P. Moriarty III

Concern Regarding New Frontiers 5

- Second Community Announcement (allowable Moon mission themes):
  - "Mission investigations will be limited to the following mission themes (listed without priority), with the science objectives specified in either the Decadal Survey or the previously issued New Frontiers 4 AO:
    - Lunar South Pole-Aitken Basin Sample Return (pending Artemis landing site selection(s) and science objectives)
    - Lunar Geophysical Network

- **What does "pending" mean?**
- **Does it mean this mission might be taken off the list?**
- **When would the decision to do that be made?**
- **What criteria will be used to make the decision?**

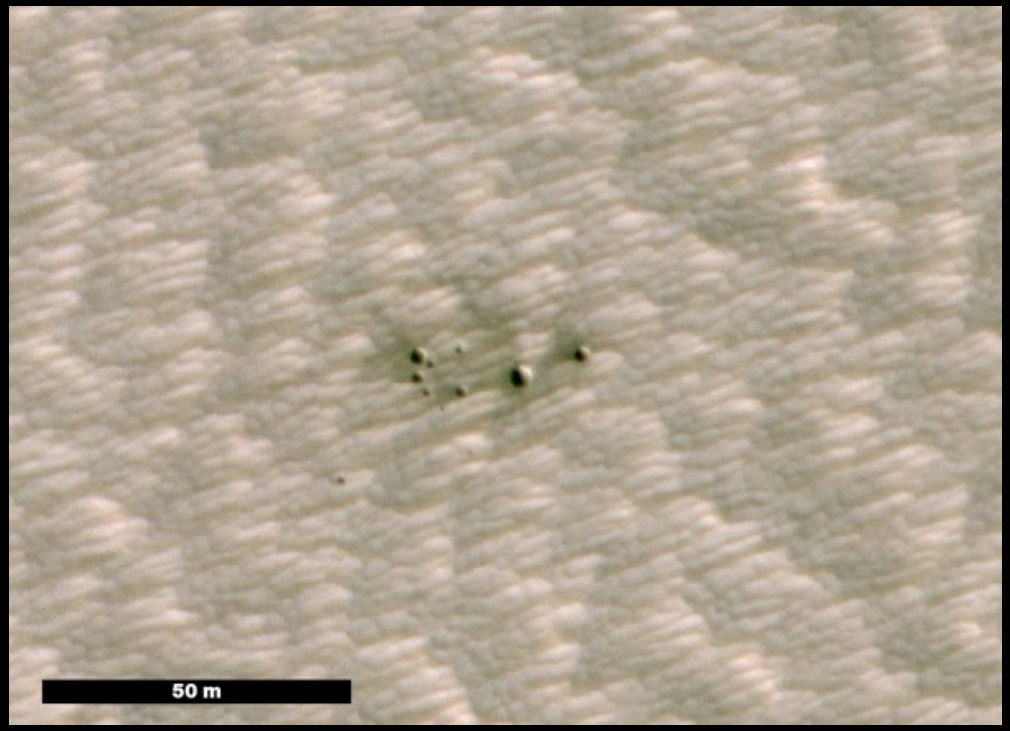
Planning Town Hall with SSERVI (January 2021)

MEPAG

MEPAG Report to Planetary Science Advisory Committee

R Aileen Yingst, Chair

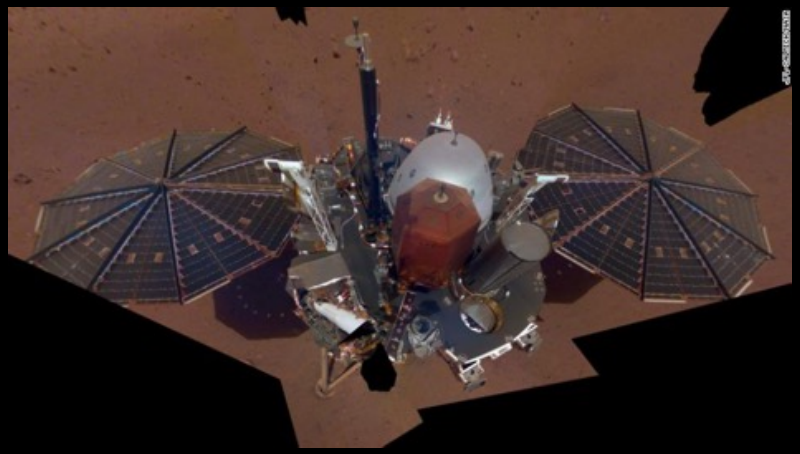
30 November 2020



The High-Resolution Imaging Science Experiment (HiRISE) camera aboard NASA's Mars Reconnaissance Orbiter took this image of a crater cluster in Noctis Fossae, the first ever to be discovered by artificial intelligence (AI). The AI first spotted the craters in images taken the orbiter's Context Camera; scientists followed up with this HiRISE image to confirm the craters. Credit: NASA/JPL/MSSS.

MEPAG Programmatics

- Committees:
  - Steering Committee (Chair: R. Aileen Yingst (PSI), appointed June 2019)
    - W. Calvin (Univ. Nevada Reno)
    - J. Eigenbrode (GSFC)
    - D. Banfield (Cornell)
    - J. Filiberto (DEIA rep #1; LPI)
    - S. Hubbard (Stanford University)
    - DEIA rep #2 (currently in search)
    - J. Johnson (past Chair, JHU/APL)
    - M. Meyer (NASA HQ)
    - D. Beaty, R. Zurek (JPL)
    - J. Bleacher/P. Niles (HEOMD, NASA HQ) Ex Officio members



Self-portrait of InSight spacecraft.

  - Goals Committee (D. Banfield, Chair)
    - Goal I <*Life*> (S.S. Johnson, Georgetown University, J. Stern, GSFC; A. Davila, ARC)
    - Goal II <*Climate*> (D. Brain, Univ. Colorado, Vacancy)
    - Goal III <*Geology*> (B. Horgan, Purdue, Becky Williams, PSI)
    - Goal IV <*Human Exploration*> (J. Bleacher, NASA HQ HEOMD; M. Rucker, P. Niles JSC)

Recent MEPAG Activities

- **MEPAG Virtual Meeting #10 (20 October 2020): Planetary Protection report**
  - Announcement of Mars Exploration Program changes
    - Eric Ianson has been named MEP Director in addition to his other duties, with George Tahu as Acting Deputy Director and Michael Meyer as Lead Scientist for MEP and MSR.
    - MSR has been moved out of the MEP, with Jeff Gramling as Director
    - MEPAG voiced concerns regarding how lines of reporting and decision-making will work between science and other aspects of MSR in this new arrangement – Dr. Ianson plans to present at the next MEPAG meeting.
    - Mars Ice Mapper science opportunities will be presented at the next MEPAG meeting; MEPAG is motivated to ensure that the science done will accomplish stated goals.
  - Reported on the NASEM Assessment of the Report of NASA's Planetary Protection Independent Review Board (PPIRB).
    - MEPAG community commends the continuing work of Planetary Protection, and encourages continued community involvement as MSR moves forward
  - Reported on the results of caucus of Analysis Group Chairs
    - AG Chairs are meeting semi-regularly to discuss issues of joint concern.

Recent MEPAG Activities

- **MASWG report released**
  - The Mars Architecture Strategy Working Group (MASWG) was tasked with determining the next steps for the Mars Exploration Program, both in parallel with, and after Mars Sample Return (MSR).
  - MASWG recommends using all the tools at MEP's disposal (e.g., small missions, Discovery, NF class) to approach the following science environments or questions uniquely accessible on Mars:
    - Access to environments fundamental to the search for past and/or present signs of life
    - Climate and habitability as an evolving, system-level phenomenon
    - The best place in the solar system to study the first billion years of the evolution of a habitable terrestrial planet
    - Outstanding opportunities to inform our understanding of the evolution of exoplanets
    - A compelling destination for human exploration and science exploration synergism.
  - The report is posted on the MEPAG website at https://mepag.jpl.nasa.gov/reports/MASWG%20NASA%20Final%20Report%202020.pdf

Recent MEPAG Activities

- **MSR IRB report released**
  - To assess whether the next phase of MSR is ready to go forward, NASA initiated a Standing Review Board (SRB) to conduct a Mission Concept Review in October 2020 as part of the process to determine whether to move the next MSR flight projects into Phase A (report this month). Unusually, an Independent Review Board (IRB) in this pre-Phase A period was asked to evaluate the technical, programmatic, and scientific readiness of the MSR campaign as a whole (multiple coupled space projects). That report was released November 10, 2020
  - The Board Report and NASA's response to the major recommendations can be found here [https://www.nasa.gov/sites/default/files/atoms/files/nasa_esa_mars_sample_return_irb_report.pdf].
  - IRB had 44 Findings with 44 Recommendations. The primary recommendation of the IRB is that the MSR program proceed.

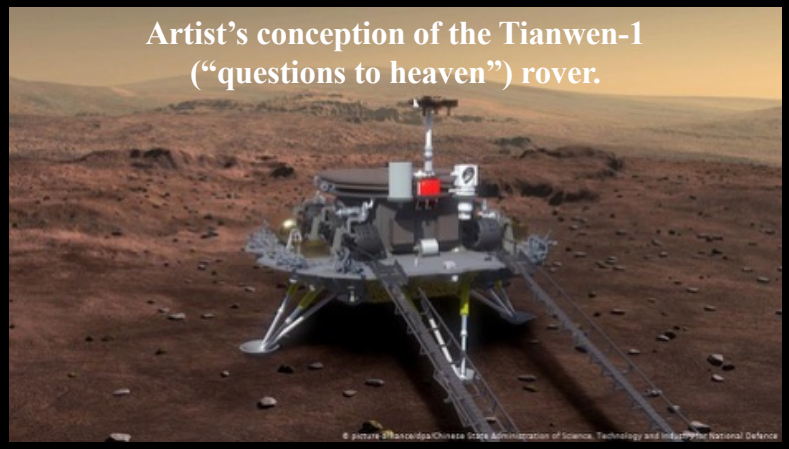
Recent MEPAG Activities

- **MEPAG preliminary response to the MSR IRB report and NASA response:**
  - *The MEPAG Steering Committee commends the decision to initiate the Independent Review Board prior to Phase A and is reassured by the Board's recommendation that, while there are issues that need to be addressed at this early stage, the MSR program should proceed, consistent with MEPAG's previous recommendations based on its scientific importance.*
  - In January 2021, the MEPAG Steering Committee plans to follow up with a virtual MEPAG meeting (VM #11) that will contain presentations and discussion about recommendations from both the IRB and the SRB, as well as responses from the MSR program offices at NASA HQ and at JPL. By then, the SRB report and program response based on the Mission Concept Review should be available, and NASA will also have conducted its deliberations regarding entry of the next MSR missions into Phase A (anticipated in December 2020).

Backup slides

Three launches to Mars!

- UAE Hope mission
- China Tianwen-1
- NASA Mars 2020 Perseverance



The UAE finished construction on its Hope spacecraft, bound for Mars, earlier this year. Image: © Government of Dubai Media Office.

ExoMARS Rover/Surface Platform: Launch still planned —2023

FY21-25 Budget

- M2020 Phase E budget is short of the money needed to be fully prepared for the desired fast-paced operations on Mars
  - Bad news: M2020 overran its development budget
  - Good news: Heroic—and successful—effort to launch on time during a pandemic saved the millions that a launch delay would have cost
- Continuing Missions
  - Efforts continue to fund Odyssey for a full year of operations, including science as well as relay
  - MSL hoping for no further decreases as it moves into the "sulfate unit" on Mt. Sharp in FY21
  - MRO and MAVEN struggling to accommodate reduced science budgets despite high SR marks
- Congress
  - House mark-up included specific call-out to fund ODY and get on with MSR
  - Federal government is in continuing resolution

MEPAG 38 Findings summary — 1: MSR and beyond

- Mars Sample Return (MSR) (Finding #1, Finding #2)
  - MEPAG commends the exemplary technical progress in the formulation of the next MSR campaign flight missions including solid NASA-ESA partnerships. These are long-awaited steps needed to make a major advance in our understanding of Mars and of solar system processes.
  - MEPAG commends the efforts by NASA to update the Planetary Protection procedures and documents (many now in review), and the involvement of a wide diversity of experts. The proposal to formalize this process as it relates to MSR through a board to address sterilization and molecular deactivation issues is a positive next step.

MEPAG Findings summary — 2: Mission findings

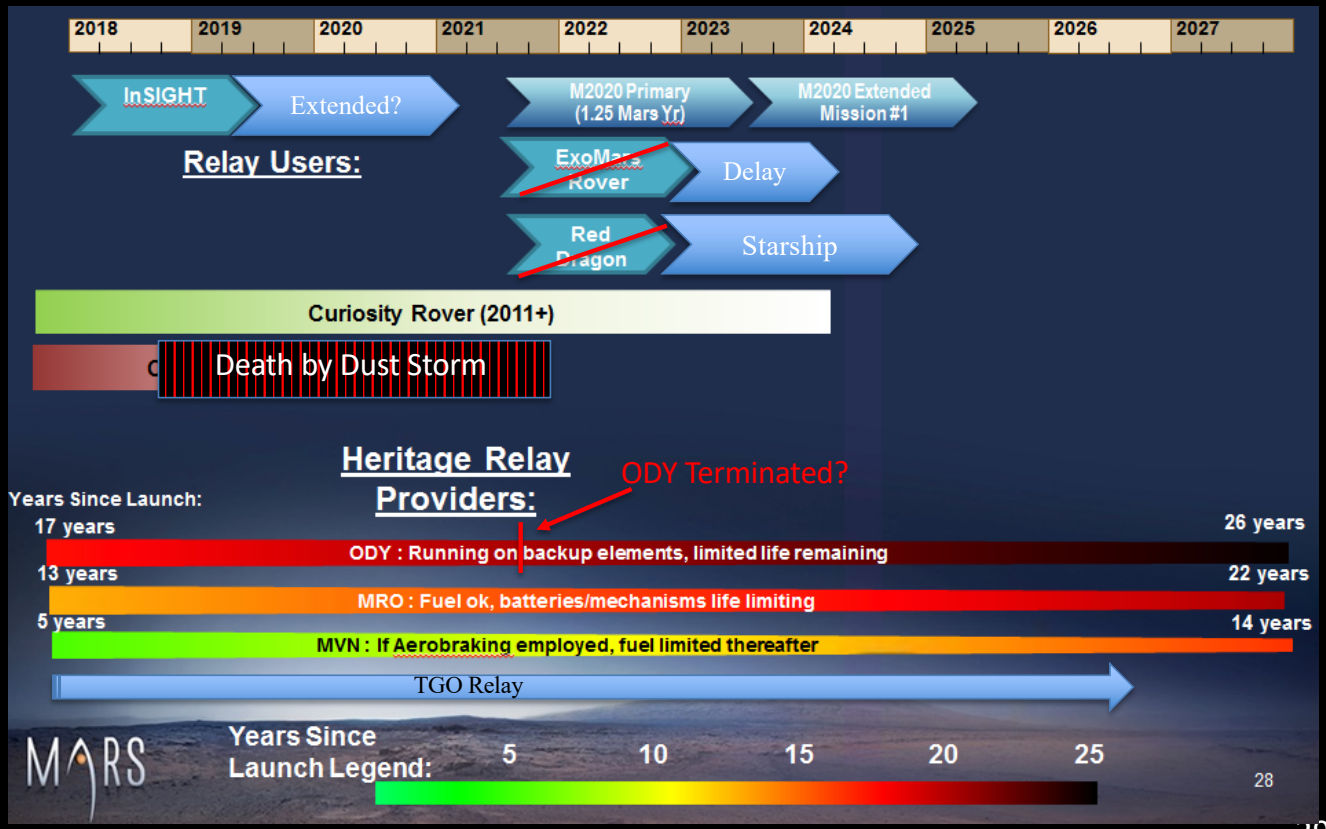
- Ice Mapper (Finding #3)
  - MEPAG is concerned that the process by which the Mars Ice Mapper mission appeared in the Mars mission portfolio, its scope, and the plans for its funding were unclear. MEPAG encourages greater transparency and community involvement in the formulation of this concept, in keeping with recommendations by MEPAG-sponsored science analysis groups and the *Visons and Voyages* document. Consequently, MEPAG recommends that PSD/MEP form a Mission Design Team (MDT), including scientists from the participating international partners and specialists from HEO, to review the M2M campaign requirements and to define appropriate instrumentation for the ice-as-a-resource mapper. To address the ice science objectives formulated by MEPAG through its science analysis groups (e.g., Ice and Climate Evolution Science Analysis Group [ICE-SAG], 2019) would require additional measurements (beyond the proposed SAR). The MDT could consider what additional instrumentation would be needed to realistically address the remaining ice science objectives. Should such objectives be included, MEPAG would recommend that the instruments to meet those objectives be competed.

MEPAG Findings summary — 2: Mission findings

- Senior Review mission funding (Finding #4)
  - MEPAG notes a disconnect between Senior Review funding recommendations for highly-rated extended missions, and the budget profile for FY 21 (e.g., decreases for three missions rated Excellent/Very Good, some of which were recommended for increased funding).
    - This finding was made before a reshuffling of budgets within the MEP. ODY, for example, has been given some budget relief.
- International missions to Mars (Finding #7)
  - MEPAG enthusiastically applauds the heroic support of current operations and launch activities in extremely difficult circumstances associated with COVID-19. Where possible and appropriate, MEPAG encourages NASA to leverage international missions and increase international collaboration by supporting Participating Scientist or Guest Scientist programs to these missions.

MEPAG Findings summary — 3: Infrastructure (Finding #5)

- The communication infrastructure is aging but continues to provide crucial science data. The relay burden will only increase given the arrival of missions to be launched in the next decade.
- *MEPAG encourages a systematic approach to supporting Mars relay requirements, including innovative solutions such as smallsats and commercial ventures.*



MEPAG Findings summary — 4: R&A (Finding #6)

- The Administration's FY21 budget contains an increase in support for Research and Analysis (R&A) and the House budget retains this increase. R&A is crucial in realizing the benefits of missions, and in transferring the benefits of robotic missions to human exploration efforts.

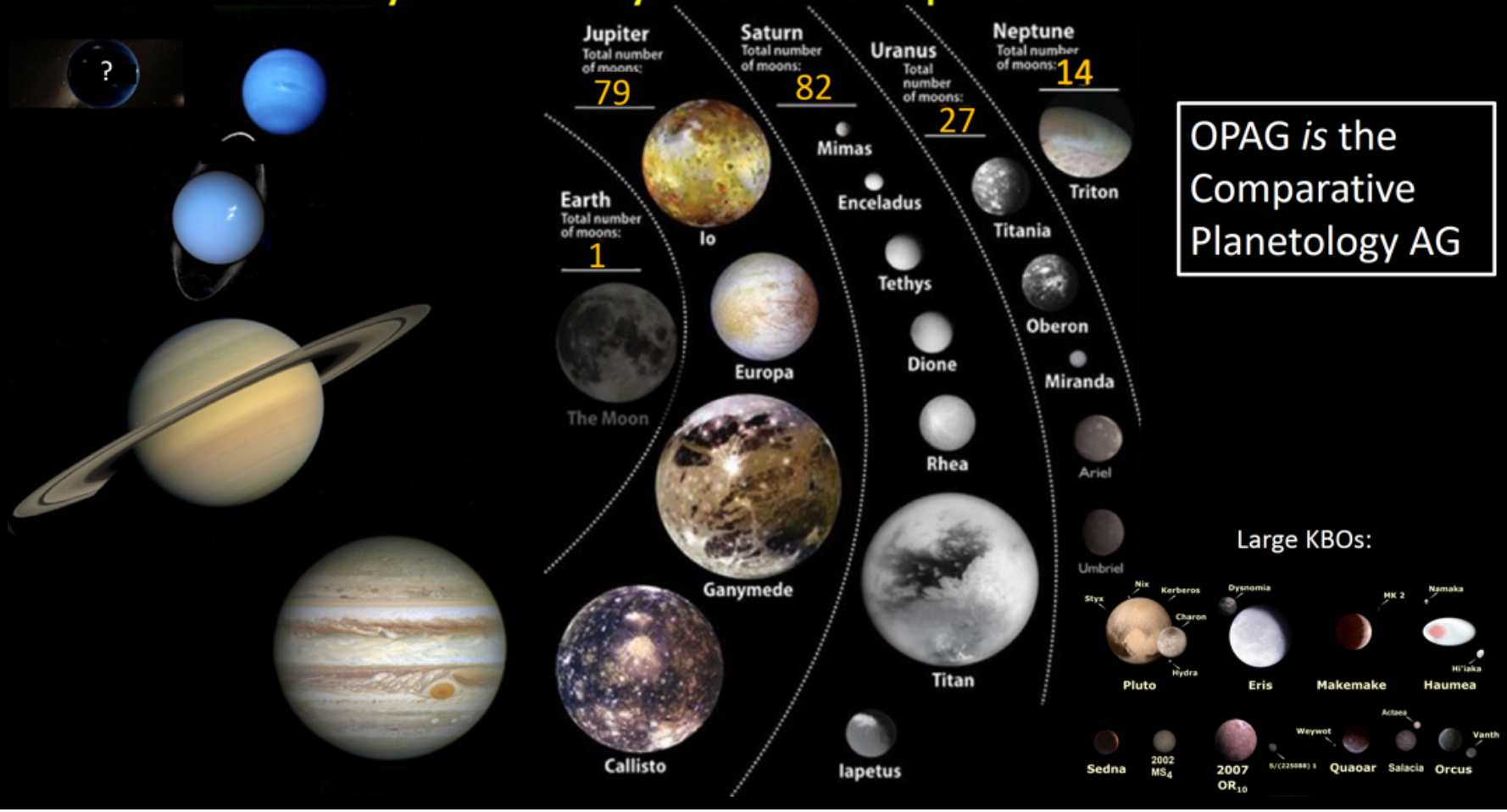
- *MEPAG is encouraged by the augmentation of the R&A budget for all planetary science (**not just Mars**), an action that enables flight missions to provide increased benefit to scientific knowledge, inform other NASA programs such as HEO, and increase the robustness of the next generation of scientists who will sustain NASA programs into the future.*

OPAG

OPAG Update to the Planetary Science Advisory Committee (PAC)

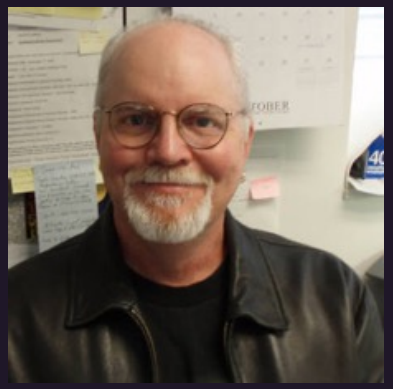
Linda Spilker (JPL), Jeff Moore (NASA ARC), OPAG Co-Chairs, PAC Meeting, 30 November 2020

Outer Solar System: Many Worlds to Explore



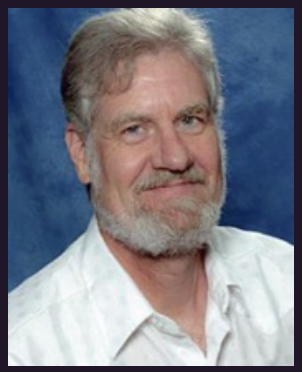
OPAG *is* the Comparative Planetology AG

OPAG Steering Committee



Jeff Moore
OPAG Co-Chair
Ames Research Center

Linda Spilker
OPAG Co-Chair
Jet Propulsion Lab



Alfred McEwen
University of Arizona

Lynnae Quick
NASA Goddard

Kathleen Mandt
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Morgan Cable
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Britney Schmidt*
Georgia Institute of Technology

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Tom Spilker
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Abigail Rymer
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* =Rolling off

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Jeff Bowman*
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Terry Hurford
Goddard Space Flight Center

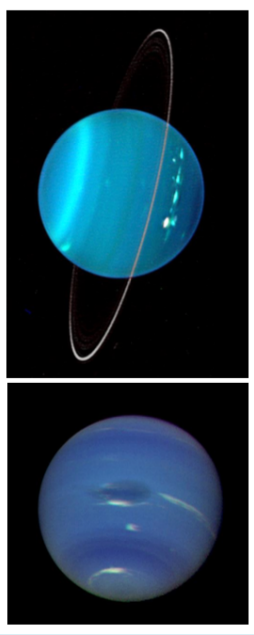
Carol Paty
University of Oregon

* =Rolling off

Outer Planets Assessment Group (OPAG) Charter

https://www.lpi.usra.edu/opag/

- NASA's community-based forum to provide science input for planning and prioritizing outer planet exploration activities for the next several decades
- Evaluates outer solar system exploration goals, objectives, investigations and required measurements on the basis of the widest possible community outreach
- Meets twice per year, summer and winter
  - Next meeting (virtual): 9 – 10 February 2021
- OPAG documents are inputs to the Decadal Surveys
- OPAG and Small Bodies Assessment Group (SBAG) have Joint custody of Pluto system and other planets among Kuiper Belt Objects



KBO planets

Recent and Upcoming OPAG-related Meetings

- **OPAG Meeting** (1-3 September 2020) (Virtual)
  - Focused on upcoming Planetary Science and Astrobiology Decadal Survey

Upcoming Meetings:

- **Town Hall at AGU** (December 2020)

- **OPAG Meeting** (tentatively 9 – 10 February 2021) (Virtual)
  - Focus on upcoming Planetary Science and Astrobiology Decadal Survey

OPAG Late-Breaking Major Concern

- **Decrease in budget for Decadal mission studies**: In numerous public presentations in the August-September timeframe, the planetary science community was told by David Smith and Lori Glaze that roughly 10 mission studies would be performed in addition to the PMCS studies, at a cost of roughly $10M. Recently the Decadal Survey co-chairs were told that PSD only has $4M for mission studies (roughly 4) along with some deltas to previous studies.

- Questions from OPAG:
- a. What happened to the $10M originally allocated to mission studies for the decadal survey that leaves only $4M for studies?
- b. When is the planetary science community going to be notified about this change by NASA?
- c. What will happen to the mission concepts that CAPS suggested be studied, or that received Excellent PMCS reviews, that may not be studied at all given the decrease in available funding?
- **Recommendation**: OPAG recommends that additional funds be found, up to the original $10M, to enable requests for ~10 additional mission studies to be performed as part of the Decadal Survey. Limiting additional mission studies to only four missions may limit the range of potential planetary missions for the coming decade.

OPAG Findings September 1-3, 2020 Meeting

- **1a. Europa Clipper Instrument Descopes (WAC).** OPAG applauds the efforts of the Europa Clipper team and NASA Headquarters to maintain the entire suite of instruments on the spacecraft. However, OPAG is concerned with the potential descope of the Wide Angle Camera (WAC) subsystem of the Europa Imaging System (EIS). While the possibility of the WAC actually being descoped was described as unlikely, the potential damage to major science return, in particular, the ability to recognize and certify potential target sites for future landed investigations, raises substantial concern. NASA should recognize the major scientific and programmatic importance of WAC to both the synergistic science return of the other experiments aboard Europa Clipper, and the potential for those results to confidently support subsequent landed missions.
- **1a. Finding:** OPAG strongly encourages NASA to recognize the scientific importance of the EIS WAC to both the science return of the other experiments aboard Europa Clipper and the potential for those results to confidently support future landed missions, and strongly discourage the possibility of the WAC being descoped. OPAG encourages NASA to assess the impact of a potential WAC descope not only to Europa Clipper, but also the potential for those results to support future Europa exploration.

OPAG Findings September 1-3, 2020 Meeting

- **<u>1b. Europa Clipper Instrument Descopes (MASPEX).</u>** The Mass Spectrometer for Planetary Exploration (MASPEX) experiment aboard Europa Clipper is the primary instrument capable of directly detecting gases escaping from Europa's interior. While OPAG commends NASA Headquarters for its efforts to maintain the entire suite of instruments on the spacecraft, the possibility of the removal of MASPEX entirely is very worrisome and poses a threat to a significant portion of astrobiological science return of the mission.

- **1b. Finding** : OPAG is concerned about significant loss to Europa Clipper mission science return should MASPEX be entirely removed, given its potential role in understanding habitability. OPAG urges NASA to continue to make every reasonable effort to retain MASPEX at a capability no lower than that already stipulated in the performance floor for this instrument, and strenuously avoid its total removal.

OPAG Findings September 1-3, 2020 Meeting

- **2. Participating Scientist Call for Juno Extended Mission:** In the event that the JUNO extended mission is approved, the mission and the community would benefit greatly from another participating scientist call. As the extended mission would begin in 2022, such a call should be issued quickly to enable new Participating Scientists to join the Juno as soon as possible. Jupiter's satellites and rings represent an extension into new areas of science for Juno and provide an opportunity to expand OPAG community involvement with this mission. These represent the only OPAG related data sets that can be obtained over the next several years while waiting for Clipper, JUICE, and Dragonfly, and, if selected for Discovery, IVO and/or Trident. The Participating Scientist program is an important opportunity to increase the diversity of expertise on the Juno mission, and amplify the scientific return for the extended mission phase. It is also an important program for increasing diversity on the mission teams, and providing professional development opportunities to early career scientists and scientists from institutions not traditionally involved in leading missions.
- **Finding 2:** OPAG supports an additional call for Participating Scientists for the Juno extended mission to enable the greatest possible community engagement and scientific return from the extended mission. It is critical to have the call advertised as soon as extended mission decisions are made to enable rapid involvement of new PS.

OPAG Findings September 1-3, 2020 Meeting

- **3. OPAG applauds NASA for voluntarily collecting demographic data via NSPIRES.** OPAG is very supportive of this data being collected and disseminated as it helps both NASA and the community to gain a clearer picture of participation in our field and is consistent with OPAG's goal of considering diversity along multiple axes. We encourage the community to continue providing this data as it can be used to pinpoint areas of underrepresentation in our community. Importantly, while demographic data related to binary gender and career stage are routinely reported by NASA, these reports do not include demographic data as it relates to race, ethnicity, non-binary gender, or disability status, although this information is also voluntarily collected in NSPIRES. While it is important that that the community continue to provide this data, it is equally important that NASA use the data, in its entirety, in its reporting in order to pinpoint areas where representation of certain groups is still lacking in our community.

- **Finding 3:** We encourage the community to continue providing complete demographic data in NSPIRES. We also request a briefing from the Office of the Chief Scientist on how NASA analyzes this data, how the data are used, and any insights that the data has provided.

OPAG Findings September 1-3, 2020 Meeting

- **4. OPAG is concerned by the recent decrease in R&A proposal selection rates, in particular for the SSW and HW programs (both 11%).** The effects of the troublingly low selection rate are especially exacerbated given that mission and instrument AOs discourage sustainable funding levels for science Co-Is (which is a change in paradigm since Voyager through Cassini), and R&A grants are therefore expected to be the primary funding source to fund scientists in NASA-supported fields. OPAG recognizes the need to holistically re-evaluate how scientists are funded to work in NASA-supported fields.

- **Finding 4:** OPAG requests that NASA HQ evaluate the impact of the low proposal selection rates on the NASA-supported science communities, and share a plan at the next OPAG meeting to raise the selection rate needed to sustain a healthy science community within and among NASA ROSES programs**.**

OPAG Findings September 1-3, 2020 Meeting

- **5. Two key programs that sustain OPAG-relevant science and technology development – HW and PSTAR – have been reduced to a 2-year cadence.** This decision adversely affects maturation of science, instruments and key technologies important for addressing OPAG-relevant science questions, in particular those pertaining to habitability and astrobiology. Astrobiology is one of the top-level crosscutting recommendations of the last decadal survey, and is a primary focus of the current Decadal Survey. OPAG recognizes the importance of these programs as a backbone that supports those science goals.

- **Finding 5:** OPAG strongly objects to the decision to reduce the cadence of the HW and PSTAR programs. If the 2-year cadence becomes permanent, OPAG requests that NASA HQ implement a strategy to prevent the loss of science and technology development that would have been funded through these programs.

SBAG

SBAG Steering Committee Concerns and Issues

1. Radar astronomy has been at the core of NASA's program in planetary defense. Arecibo Observatory has historically provided key information for characterization and tracking of NEOS, which in turn forms the basis for mitigation strategies. SBAG is shocked at the recently announced plan to decommission Arecibo. SBAG recommends that NASA develop a plan to recover the work on NEOs done at Arecibo, perhaps by enhancing radar capabilities at Deep Space Network facilities or by collaborations with Green Bank Observatory and others.
2. SBAG continues its support of a two-prong effort for meeting the national mandate to discover 90% of NEOs larger than 140 m by 2030. The first effort is the deployment of an infrared camera such as NEO Surveyor, and the second is the use of ground-based assets such as the Vera Rubin Telescope.
3. SBAG continues its strong support of NASA's participating scientist programs, including the establishment of a protocol for selecting participating scientists for international missions.
4. For the New Frontiers program, the targets should be specified based on recommendations of the Decadal, but NASA should ask the National Academies for renewed advice prior to the release of each AO.
5. The small bodies community is concerned about possible cuts to research programs, and the associated risks to early and mid-career planetary scientists.
6. The SBAG Steering Committee is concerned that funds dedicated to the Decadal Survey to study possible missions are not sufficient. Originally 10 such studies were supported, but we heard it was now only 4, which is not adequate.

CAPTEM

CAPTEM Report to Planetary Science Advisory Committee

Barbara Cohen, Incoming Chair

Kevin McKeegan, Outgoing Chair

30 November 2020

Current CAPTEM organization

- CAPTEM is a community-based, interdisciplinary forum for discussion and analysis of matters concerning the collection and curation of extraterrestrial samples, including planning for future sample return missions.
- CAPTEM constitutes sub-committees, each responsible for one or more of NASA collections of ET samples and charged with evaluating proposals requesting allocation of samples
- In its role as an analysis group, CAPTEM may also organize ad hoc or standing subcommittees to address specific issues. In principle, this includes supporting human exploration objectives and their implications for architecture planning and activity prioritization for future exploration of planetary surfaces.

CAPTEM membership

- Chair: Kevin McKeegan (UCLA), Vice-chair: Hope Ishii (UH), Secretary: Liz Rampe (JSC), Chair-elect (2021): Barbara Cohen (GSFC)
- Sub-committee chairs or coordinators
  - Lunar: Juliane Gross (Rutgers)
  - Genesis: Larry Nittler (CIW)
  - Stardust: Rhonda Stroud (NRL)
  - Asteroids: Munir Humayun (FSU)
  - Cosmic Dust: Hope Ishii (UH)
  - Space Exposed Hardware: Jeff Taylor (UH)
  - Facilities: Kevin McKeegan (UCLA)
  - Informatics: Sam Lawrence (JSC)
  - Meteorite Working Group: Jon Friedrich (Fordham)
  - Mars: Justin Filiberto (LPI), Caroline Smith (Nat Hist Mus, London)
- At-large members: Jessica Barnes (UA), Jemma Davidson (ASU), Lydia Hallis (U Glasgow)

CAPTEM is changing!

- All AGs going through formal charter changes, CAPTEM is no exception
- CAPTEM's unique dual role as both analysis group and allocation group has to change
- Allocations:
  - Allocations will be run as traditional NASA Review Panels that are separate from the AG function
  - Review panels will be initiated by the appropriate Curator and supported by NRESS
  - Requests will be submitted through NSPIRES and archived
  - In practice, the CAPTEM subcommittees contain substantial subject-matter expertise that the Curator will draw on when forming a Review Panel
- Analysis:
  - Committee will continue its role in providing expertise and analysis on collection, allocation, and curation activities (Spring meeting)
  - Expand its AG role to better serve the sample-analysis community; e.g., discuss initiatives, reports, missions, findings and studies as requested or initiated (Fall meeting)
- The CAPTEM name will change! The leading candidate is Extraterrestrial Sample Analysis Group (ExSAG) – *your comments and ideas on this name are welcome*

CAPTEM subcommittees

- Most subcommittees will gradually change as they get more comfortable with their dual functions
  - Lunar Sample Subcommittee (Apollo, Luna, future)
  - Cosmic Dust Subcommittee
  - Stardust Subcommittee
  - Genesis Subcommittee

  These *may* be combined into a "microparticle committee"

  - Asteroid Returned Samples Subcommittee (OREx, H1, and H2)
  - Martian Sample Subcommittee (MMX, MSR)
  - Space-Exposed Hardware
  - Facilities Subcommittee
  - Informatics Subcommittee

  These are different functions but *may* be rolled together

- Meteorite Working Group is a special beast because of the 3-agency agreement (NSF, NASA, Smithsonian). MWG has already updated their subcommittee charter to separate their roles and prefers to keep the MWG moniker for now.

COVID-19 disruptions

- Like all groups, COVID-19 caused significant disruption
- Spring Meeting (held in conjunction with LSPC) was abruptly canceled. A one-day virtual meeting was held March 18 with somewhat abbreviated activities and reports.
  - Spring meeting 2021 will also be virtual, planning to begin imminently
- Because of JSC center closure, sample requests for Lunar samples and Antarctic Meteorites were not solicited in Fall 2020
  - Working on understanding whether the next call for Lunar and Meteorite sample requests will occur before or after the typical time of year that we solicit spring requests.
- Collections that accept rolling requests continue to be accepted, but sample processing and allocation delays have led to substantial backlogs

CAPTEM white papers

- CAPTEM contributed to the Planetary Science and Astrobiology Decadal Survey process by nominating members and writing white papers
  - Advanced Curation of Astromaterials for Planetary Science Over the Next Decade (J. Allton)
  - Strategic Investment in Laboratory Analysis of Planetary Materials as Ground Truth for Solar System Exploration (R. Stroud)
  - Terrestrial Recovery of Extraterrestrial Materials: Providing Continued, Long-Term Sample Analysis Opportunities for Research and Mission Support (H. Ishii)
- Community-contributed white papers highlight the sustained interest in acquiring new samples from across the Solar System in the next decade
  - Why Mars Sample Return is a Mission Campaign of Compelling Importance to Planetary Science and Exploration (H. McSween); Mars, The Nearest Habitable World, A Comprehensive Program For Future Mars Exploration (B. Jakosky); Scientific value of returning an atmospheric sample from Mars (B. Jakosky); The importance of the study of igneous rocks and compositions to constrain the martian planetary evolution (A. Udry)
  - High Priority Returned Lunar Samples (S. Valencia); Sample Return from the Moon's South Pole-Aitken Basin (B. Jolliff)
  - Cryogenic Comet Sample Return (A. Westphal); Volatile Sample Return in the Solar System (S. Milam); The Case for Non-Cryogenic Comet Nucleus Sample Return (K. Messenger); Small Bodies Tell the Story of the Solar System: A Rationale for a Small Body Sample Return Program including Laboratory Analysis of Returned Samples(S. Jacobsen); Ceres sample return PMCS (J. Castillo-Rogez)
  - Mercury sample return to revolutionize our understanding of the solar system (K. Vander Kaaden)
  - Returning Samples from Enceladus for Life Detection (M. Neveu)
  - Interplanetary and interstellar dust as windows into solar system origins and evolution (M. Horanyi)
- CAPTEM as a body also reviewed and chose to endorse several EDI White Papers
- Though current Survey Panels are organized by destination, as a crosscutting AG, CAPTEM members stand ready to provide additional input to the Decadal Survey process

Artemis III Science Definition Team

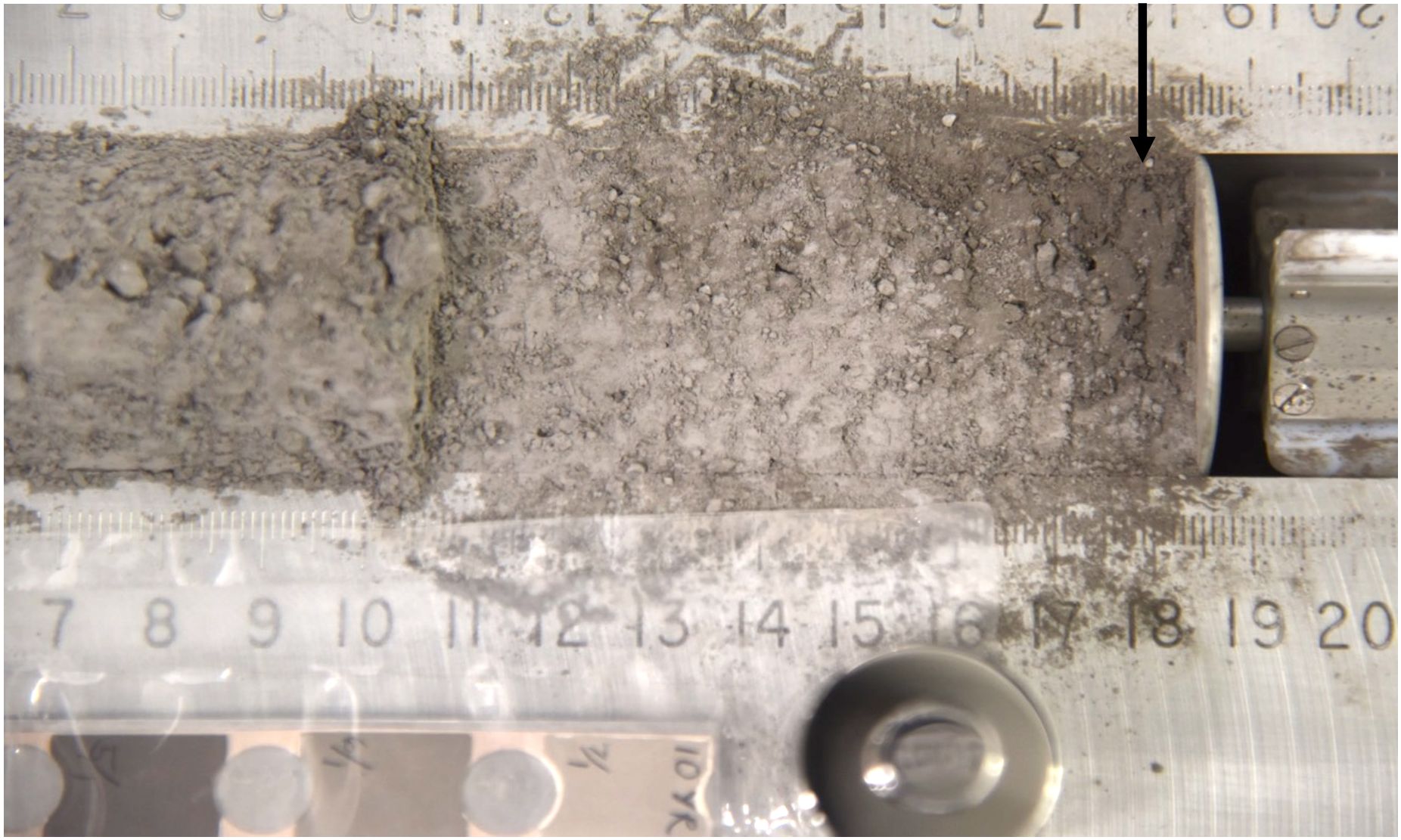
- The Artemis III SDT was charted by Thomas Zubuchen for NASA SMD to define compelling and executable science objectives for the Artemis III mission, the first human mission to the surface of the Moon in the 21st century.
- Stood up early September, Final Report completed Nov. 13
- SDT membership included Chair of the CAPTEM Lunar Sample Subcommittee (J. Gross) to provide sample community perspectives on science traceability and requirements
- In particular, this expertise was appreciated for general sample return recommendations, tools, and materials inputs
- Continued interaction between Artemis III engineers and CAPTEM (and LEAG) is recommended for help refine site-specific science activities, tools, collection and curation details

ANSGA update

- Work has resumed on processing 78001 (upper half of core sample)
  - Pass 1 has been processed and is completed with 37 dissected intervals (18.5cm core length, 0.5cm per interval)
  - Pass 2 dissection is 25% completed as of Nov. 24
  - 29 sample allocations (from 15 different intervals) from pass 1 have been sent out to ANGSA PIs as of this week.
  - The external PE team isn't allowed onsite, considering live video feed for processing observation
- 78002 is the pristine sample to be opened. A Gas Extraction System has been designed to collect the head gas, now developing piercing tool. Full core will be opened and processed after 78001 is completed.
- Thin section lab is working on grain mounts of unsieved material and the core vacuum impregnation system
- CT lab is also back up and running, has scanned >60 individual rocklets
- Cold curation - cabinet almost ready to go into the freezer and get cleaned. Have new balances that are calibrated. And the plan for moving the cabinet is in place. Just waiting for a few detection systems to be installed.
- ANGSA presentations at AGU 2020 (6 talks, 19 posters) and in a Special Session at LPSC 2021

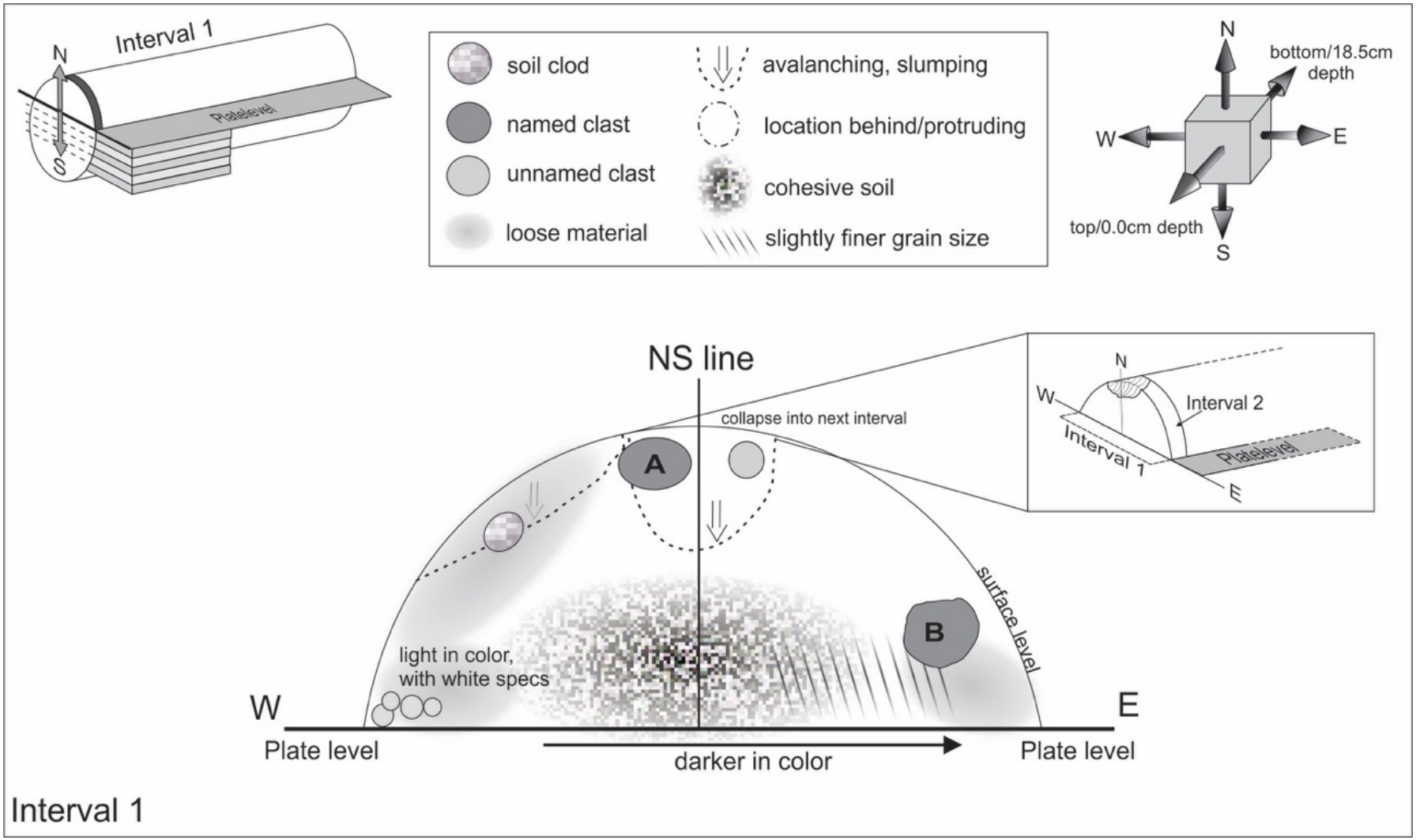
ANSGA update

Darkening due to space weathering



First 16 intervals dissected. Space weathering at the lunar surface (right side) is evident in the darkening of the exposed soil.

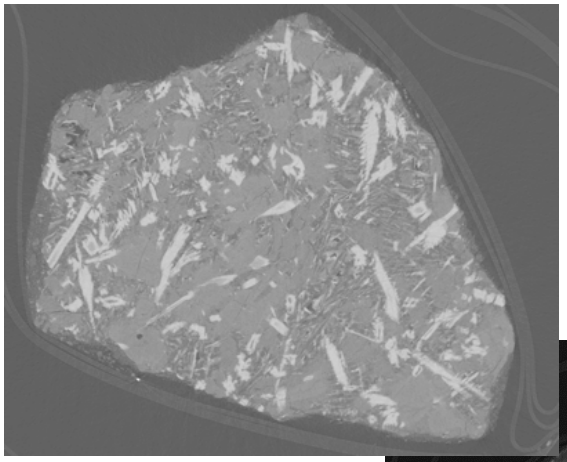
ANSGA update



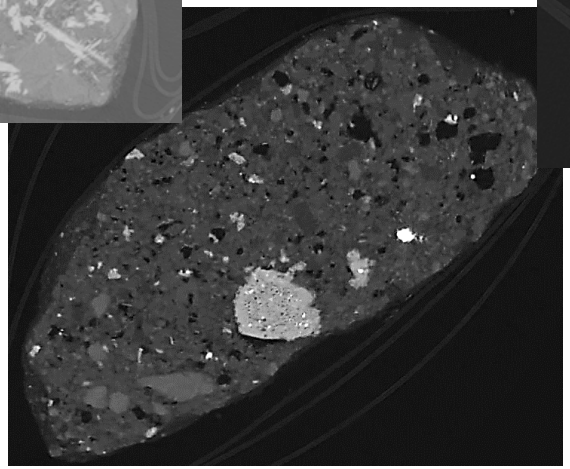
Interval 1 PE sketch (note, sketch is a combination of information pulled together into one image; it includes information from pictures taken, notes, and drawings made during dissection)

ANSGA update

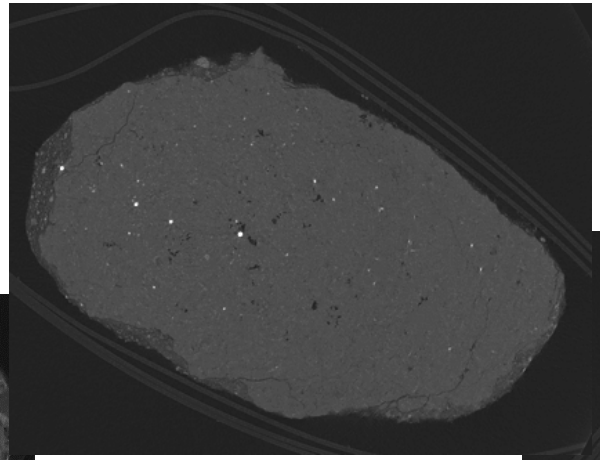
- XCT data of individual particles (60 particles total were scanned, only > 4mm fragments were scanned)
  - XCT data are crucial because all clasts are covered in dust that is very static and clings to the particles.



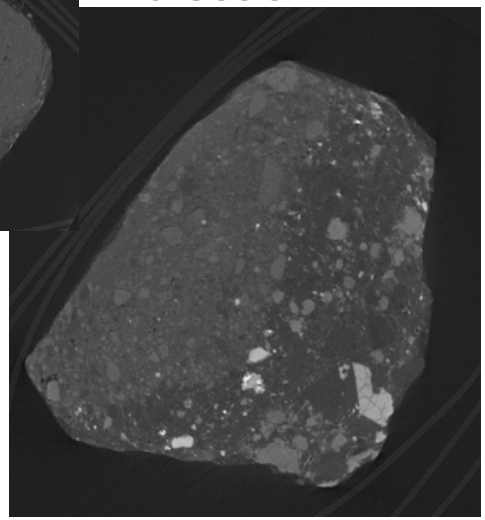
Basalt



Vesicular regolith breccia



Impact melt



Polymict regolith breccia

(Note: All 4 fragments seen here are 5mm in the longest dimension

ANSGA update

First 28 samples from pass 1 ready for processing and allocation (very happy core team ☺ - Juliane, Andrea, Charis)

MAPSIT

MAPSIT Findings (full text)

1 - Analysis-ready planetary data accelerates scientific progress. Missions should strive to provide analysis-ready data, but if they do not, then their data delivery plans should include all of the needed descriptions and algorithms in order for a 3rd party to take their archived data and produce analysis-ready data.

2 – The MAPSIT steering committee has commissioned a group of data users, mission stakeholders, and data experts to examine the possibility of a Europa Spatial Data Infrastructure. We request that NASA support the idea of this study and similar future ones as agreed upon by the MAPSIT steering committee.

3 – Given the importance of spatial data in the upcoming exploration of the Moon by robotic missions and the Artemis program, we request that NASA, through MAPSIT and possibly LEAG, establish a Lunar Spatial Data Infrastructure. A coordinated effort would ensure this process is done correctly and not involve unnecessary duplication. MAPSIT and LEAG would help determine the members of a committee to establish this infrastructure and would oversee and ratify the results of the study.

4 - MAPSIT supports the existence of the Planetary Data Ecosystem review and is glad to see community input is being encouraged and prioritized. MAPSIT would be happy to make a presentation to the PDE IRB on MAPSIT topics of expertise, if requested.

5 – We request that NASA continue robust support for the PDART program, as it is necessary to fully realize the potential of planetary spatial data. Many products that are prioritized by MAPSIT (e.g., creation of registered data products) only have PDART as their means of production.

6 – We request that NASA work with MAPSIT and the spatial data community to continue to create opportunities to train new data users and data product creators. Examples include the Planetary Data Users Workshop and short courses associated with conferences, the scope and occurrence of which could be expanded.

MAPSIT Findings in brief

1 - Missions should strive to provide analysis-ready data.

2 – A Europa Spatial Data Infrastructure has been established by the MAPSIT steering committee.

3 – We request that NASA, through MAPSIT and possibly LEAG, establish a Lunar Spatial Data Infrastructure.

4 - MAPSIT supports the existence of the Planetary Data Ecosystem review and is ready to support as needed.

5 – We request that NASA continue robust support for the PDART program.

6 – Support training for new data users and data product creators (e.g., Planetary Data Users Workshop).

ExoPAG

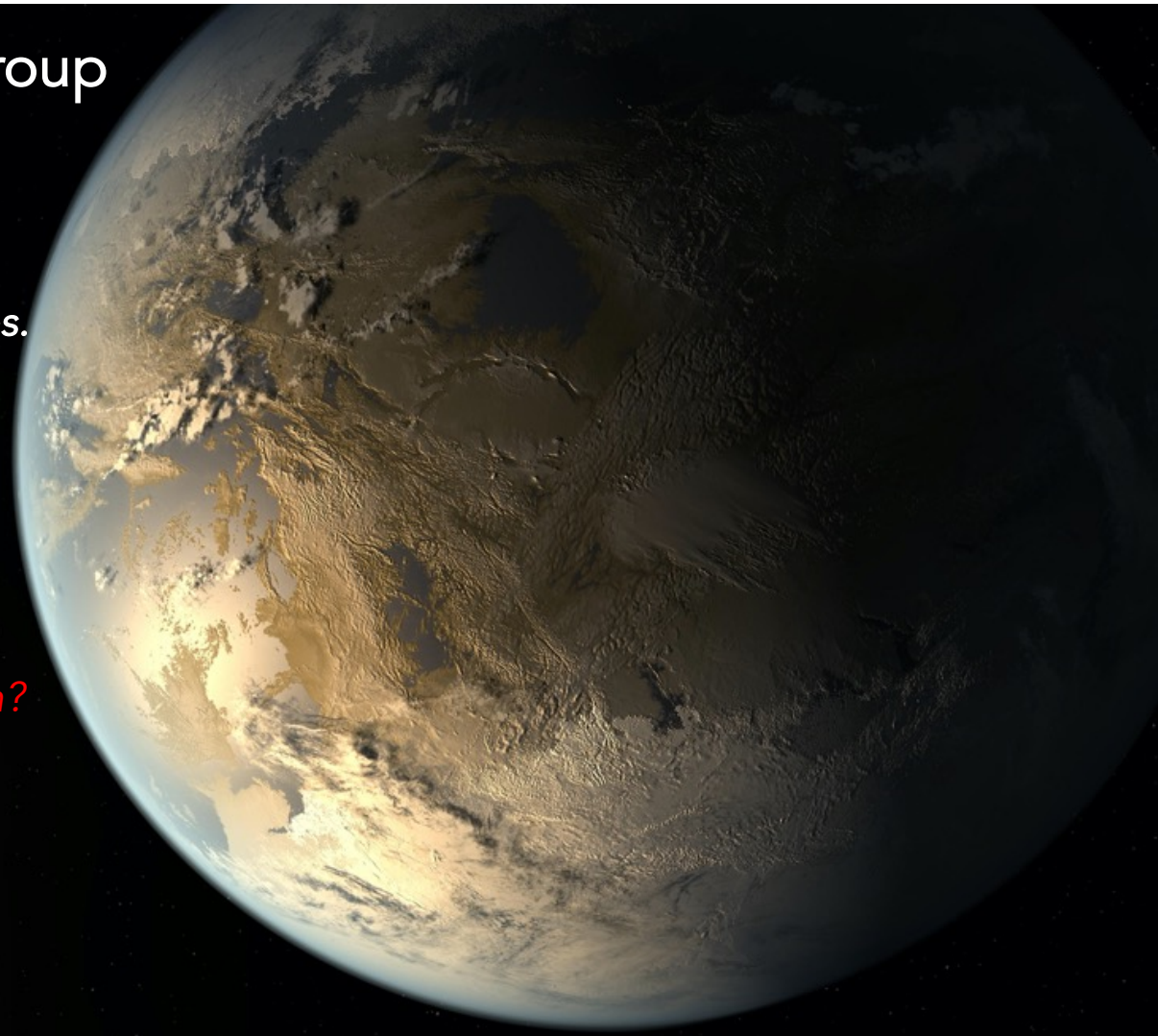
Exoplanet Program Analysis Group (ExoPAG) Report:

High level summary of most recent activities.

For review of all other activities please see presentation from August.

Question for PSAC: There have not been recent planetary science proposals for APD balloon programs. Should there have been?

Michael Meyer (ExoPAG EC Chair)
November 28th, 2020.



Planetary Science Advisory Committee, November 28, 2020

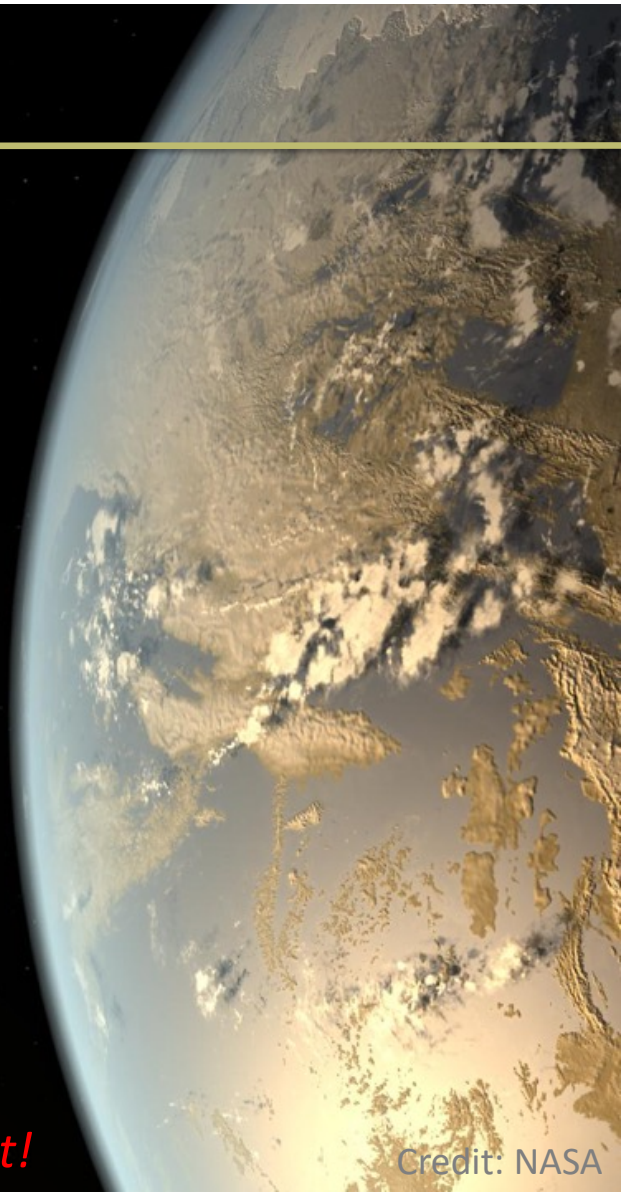
Credit: NASA

ExoPAG Executive Committee

Michael Meyer (Chair)	University of Michigan
Tom Barclay	University of Maryland
Natasha Batalha	NASA-Ames
Jacob Bean	The University of Chicago
Jessie Christiansen	NExScI/Caltech
Rebecca Jensen-Clem	UC-Santa Cruz
John Debes	Space Telescope Science Institute
Tiffany Kataria	JPL/Caltech
Josh Pepper	Lehigh University
Dmitry Savransky	Cornell
Laura Schaefer	Stanford University
Vikki Meadows (Past Chair)	University of Washington
Douglas Hudgins (Astrophysics)	NASA HQ
Hannah Jang-Condell (ExEP DS)	*NASA HQ*
Doris Daou (Planetary Liaison)	NASA HQ
Richard Eckmann (Earth Liaison)	NASA HQ
Gaylan Fowler (Heliosph Liason)	*NASA HQ*

Our newest members!

Call for new members is out!



Credit: NASA

ExoPAG Recent Activities (since last PSAC)

- Review of ExEP Science Gap List completed (Sept. 30).
  (https://exoplanets.nasa.gov/internal_resources/1547/)
- Participated in NExSS/P/AG roundtable in October.
- Community forum to prepare for January ExoPAG.
- Launch of Exoplanet Explorers!
- Presented to APAC (full day on "State of Profession" & URMs).
- New APD Cross PAG activities:
  - AAS Special Session on Barriers to URM Participation in APD Space Science.
  - Discuss new cross PAG SAG on URM in APD Space Science.
  - Review of APD Biannual Tech Gap Review at AAS in January
    (https://apd440.gsfc.nasa.gov/images/tech/ABTRCoverandPage092519Final.pdf).
- Exopag 23 (Jan. 5-6 w/ AAS) program complete.

Credit: NA

ExoPAG Community Forum – Scheduled for December 15.

Describe scope of ExoPAG analyses.

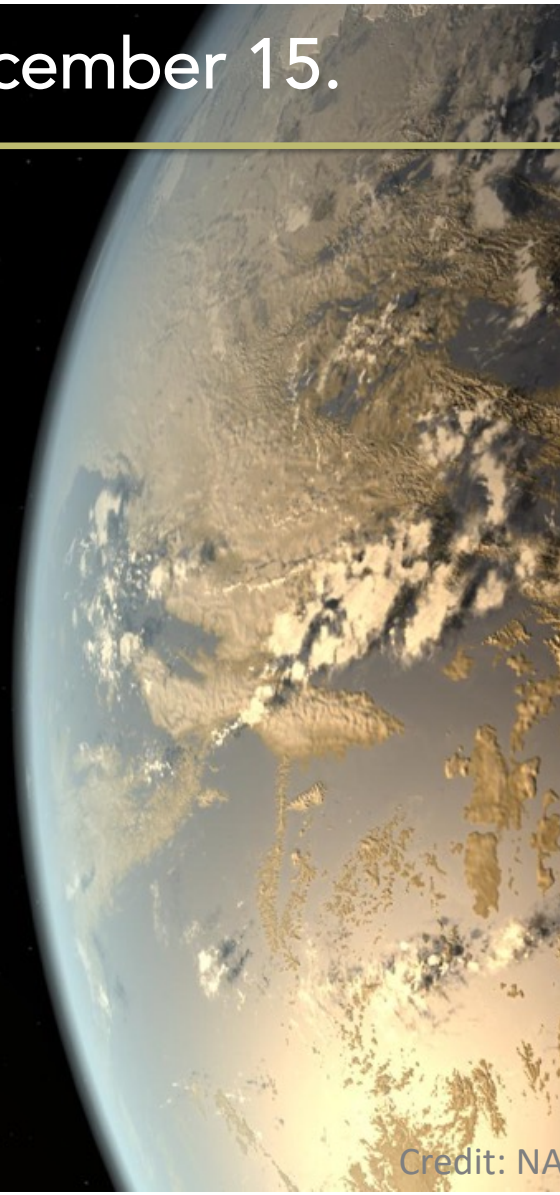
Review past "Findings".

Discuss proposed finding:

On the value of investing in interdisciplinary exoplanet science of scale over longer periods of performance (full text shared through ExoPAG Announcement).

Solicit community feedback and proposals for future findings.

Pre-meeting input and process to down-select fidings for votes.



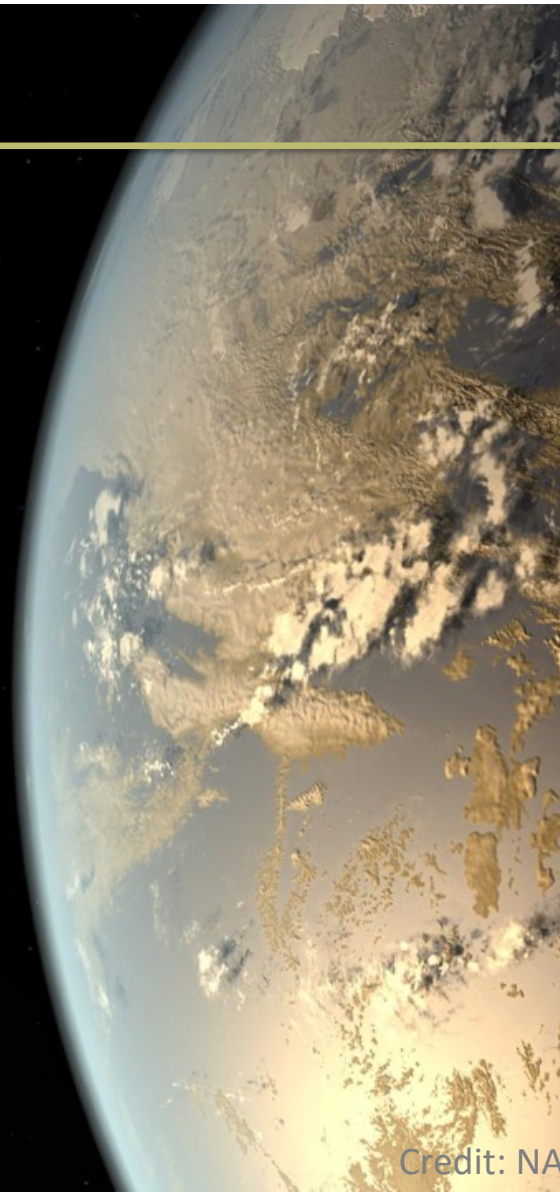
Credit: NA

Exoplanet Explorers Program Launched!

Steering Committee (all are members of ExoPAG EC):
T. Kataria (JPL), N. Batalha (NASA-Ames), J. Christiansen (IPAC), & J. Pepper (Lehigh)

Early career (grad students & postdocs) cohort for speakers series.
Half-hour monthly seminar series.
Stipend for presentation and weekly interaction with cohort.
Monthly professional development interaction with senior scientists in the field.
Additional professional development workshops to be decided by cohort.
Proposals due November 5, 2020! To be selected by ExoPAG EC.
Pilot Program January-June 2021.

For more information: https://exoplanets.nasa.gov/exep/exopag/exoexplorers/



Credit: NA

ExoPAG 23 January 5-6, 2021 Virtual

Solar System / Exoplanet Synergies Mini-Symposium!

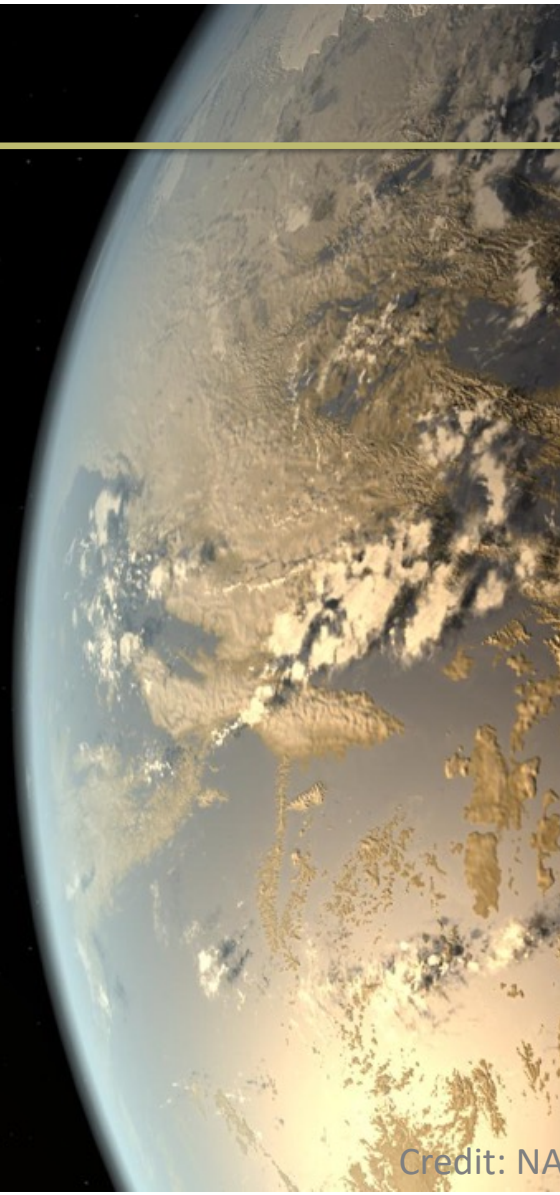
SIG3 Update (V. Meadows).
talks on Venus (M. Wong) and Ice Giants (K. Mandt).
Habitable Worlds Meeting Pre-Meeting Update (C. Unterborn)
Early-career scientist presentations.
*Panel Discussion (*Ty Robinson, Erin May, Laura Mayorga, Giada Arney).

ExEP Program Topics (HQ, Program Office at JPL, NExSci)

Science Updates

TESS Mission Updated and program notes.
Microlensing Review.
FARSIDE overview (lunar radio interferometer).
Earth Science Exoplanet Synergies (HQ overview and science talk)

Business Meeting


Credit: NA