LEAG/SSERVI Virtual Meeting - Decadal Survey White papers

May 20, 2020
Notes

12:00-13:30—Chair: Barbara; Chatroom: Amy; Notes: Rosemary
13:40-15:40—Chair: Brett; Chatroom: Ryan; Notes: Jeff
15:45-17:00—Chair: Clive; Chatroom: -- ; Notes: Esther

Notetakers: identify holes, actions, comments, things LEAG can do to help. Use this Google Sheet for real-time editing and handover

Introduction to the Decadal Survey

Speaker: Steve Squyres, past decadal chair: How to write a White Paper

White papers are the mechanism for providing inputs to the Decadal Survey. The last Decadal Survey had 199 White Papers to consider.
The White Paper is about building consensus: it is viewed as the consensus of the community written by established community groups.
The paper itself is limited to 7 pages, but it should have tracability to previous reports. The reader should be able to link to previous reports and papers where appropriate.
Authorship: Make sure that all authors have actually contributed to the writing. Don't load up on people just to seem to be a consensus of the community.
Science: Always tie it to the science:

- Key science question
- What new technology is needed to answer the key science questions
- New directions for R&A programs

AVOID:

- Avoid "Us vs. Them" (i.e lunar vs. non-lunar segments)
- This is a "planetary" decadal survey, not a lunar science decadal survey

Don't fall into the trap of current focus = future focus. Example: last time the focus was on asteroid science, now the focus is on the Moon-Mars initiatives. do NOT assume that the focus will stay the same. It never does.

DO: Understand that there is always a trade of the ratio of science return/cost.
Show how lunar science advances planetary science.
Focus on new lunar science since the last decadal.
Pay attention to communications from the decadal leadership.
Understand the unique aspect of resumption of human presence on the lunar surface and the chance to carry this over.
Identify and clearly state priorities.
Build consensus
Be concise. Avoid jargon. Clear concise writing is essential.

READ: Read the Survey's Statement of Task (On Decadal Website)

QUESTIONS:
1. Renee Weber (MSFC): How do you write the defining paper of your career during the Covid-19 pandemic? Answer: Good use of collaboration tools. (Flexibility in the schedule is not going to happen even though it would not be a bad thing.) Don't "dash off" a white paper. Papers are often written with long-range collaboration, so this is not at all unusual. Steve suggested loosening the date would be a good idea, give the fact that he's requesting career-defining papers in a time when people are working with home and managing kids and dealing with other distractions.

2. Peter Schubert: Pure scince vs. application? Answer: Technology should be tied to the science. Technology in search of an application is not what is wanted.

3. Paul Lucey: Seven pages is short. On complex subjects is it better to have one white paper or ten or what? Answer: A 70 page white paper cut into 10 white papers is not a good approach. The best way to manage the page limit is good referencing. A lot of reports already represent the community view. The best way to keep the number of white papers manageably low is good referencing.

4. Barb Cohen: Flavors of recommendations: R&A money, missions? Answer: Opening sections always deal with the science. First a statement the science at the time of writing is of considerable value. State the knowledge gaps. State the priorities. Second flow down to R&A , missions, objectives. The last two pages should discuss measures that might fill in the knowledge gaps.

5. Clive Neal: The last time there was a tight-rope between what could be said and what could not be said. The last time the emphasis was on asteroids and not on the Moon. Now Artemis is real. How to deal with SMD-HEO? Answer: Now we have the opportunity to establish science priorities for surface exploration of the Moon. Look at the "Statement of Task." It is different from the last decadal.

David H. Smith, Planetary Decadal Study Director

David Smith recommended people watching this video recorded May 7 earlier career Whitepaper 101 workshop. https://vimeo.com/418576172

Statement of Task and other general information about the decadal survey: https://www.nationalacademies.org/our-work/planetary-science-and-astrobiology-decadal-survey-2023-2032

Read the Statement of Task - it contains advice: scope, considerations, approach. This is important but not binding. However do not go over the scope.

White paper submissions will be accepted until 11:59 p.m. EDT, July 4, 2020. The July submission deadline is not arbitrary (July 4th is a soft-closing and papers will be accepted until early August.). Survey reports must be delivered to the sponsor by 31 March 2022. This deadline can only change if NSF changes the due date. The deadline requires that the surrey committee start work in August. The survey committee needs 4-6 to read and digest reports. To get the report delivered by March 22 which will impact budget planning for FY23.

Overview:
Broad survey of state of knowledge
Top level science questions
Optimum balance between target bodies
Assessment of infrastructure
Strategic technology
NOT which missions should fly.

This time there is
a higher profile on astrobiology and planetary defense;
Activities clearly traceable to goals and objectives;

Cross-disciplinary and across SMD directorates.

Pay attention to Item 1d: Mars and the Moon

Item 4: opportunities for investing in involving humans in-situ and the value of human tended investigations.

Early career opportunities: see vimeo.com/418576172

<<Dave Smith's advice is counter to Steve Squyres advice in multiple areas.>>

Questions:

Q: Will the Decadal survey be organized by planet or by topic? A. The webpage has multiple categories and can select multiple: Bodies, Topic, technique etc. Good strategy: Cross-reference other WP.

Peter Schubert: Is a shorter paper more important? Answer: You need to get your idea across. If the idea is of interest the author will be invited to present it to the committee. The idea is the key.

Clive Neal: The deadline is a NASA requirement to get the ideas into the 2024 budget? Answer: 4 July is set by the National Academies based on the due date of 31 March 2022 and previous experience.

Will there be more mission studies? There is a legal requirement to do mission studies. There are currently 11 PMCS studies (Planetary Mission Concept Studies) Lori Glaze has funded maybe 10 more. They take months.

Solar System formation, dynamic processes, and chronology

Brad Jolliff: Sample Return from the Moon's South Pole-Aitken Basin
New Frontiers Class Mission

Barb Cohen: Geochronology for the Next Decade

New Frontiers Class Mission, expand the NF call to encompass sample return and in situ science to address key questions like bombardment

Habitability and water/life and prebiotic organic

Dana Hurley: Lunar volatiles PSR Mission

- Call for concept study
- Currently no co-authors?
- What science and be accomplished under the New Frontiers cost cap.

Parvathy Prem: Lunar Volatiles and Solar System Science

- The last decadal survey occurred before a sea of changes in understanding the presence of volatiles on the Moon (LCROSS) and asteroids (DAWN).
- Concept study: review advances in understanding volatiles over the last 10 years, and identify outstanding questions.
- Important science to be done from orbit and on the surface
- investments in technology development
- continued investment in R&A
- Support for US participation in international partnerships

- A growing list of co-authors, but none listed.

Paul Lucey: The Lunar Volatile Cycle

- Outline many open issues: migration of volatiles within the system, quantitatively describe measurement requirements to meet science needs.
- Goals: Actual ongoing dynamics and migration
- Importance of non-PSR soils
    - Hematite at high latitudes > oxidized phase (!!)
    - Unknown H budget at the poles

Bill Farrell & Ester Beltran: Lunar Polar Volatile Resources: Obtaining Their Origins Prior to Extraction

- Determine the origins of polar deposits to understand if they are astrobiologically significant and therefore need protection. Needs to be done before human modification.
- Answer to origins question may affect approach to resource mining.
- Is an Environmental Impact Statement needed

Avoid contamination and volatile loss
High priority Flagship mission (lander/rover)
SSERVI should write an environmental impact statement: "avoid harmful contamination"
Recommend mission into a PSR like Cabeus, something like PIPELINE (Hurley, APL)
get at origins before it is altered (e.g. S.A. Stern priority for LADEE)

David Paige: Low-Velocity Penetrator Networks for Lunar Polar Science and Exploration

Mission concept: low-velocity penetrators (dozens of 1kg ballistic probes, 150m/sec)
Measurements: regolith structure to > 10 m depth; and composition/Volatiles at ~1 m depth
Instrument concepts for measurements not given

Discussion:
Barb Cohen suggested: LEAG to propose (as a white paper) the urgency to have a polar volatile mission study to this decadal survey. This topic has missed previous decadal study and not selected as a mission concept study.

Ron Creel: what volatiles are you talking about? Is this just water? there are other volatiles of interest such as Ar, Ne, S, Na, K, H, H2, He, CO, Ch4, Hg

Paul Lucey: How does the solar wind influence polar volatiles? Urgency in sampling the lunar volatiles before we destroy the pristine state.

Brad Blair: Study of volatiles deposited by each lunar landed missions. Rocket fuel could be spiked with certain isotopes for COVID like tracing. ;-)

Carle Pieters: the immediacy of measuring lunar volatiles while they are still pristine is critical. the 2007 SCEM report was written before these issues emerged. Ed Note: The SCEM report is not the latest document we have to work with, see ASM-SAT https://www.lpi.usra.edu/leag/reports/ASM-SAT-Report-final.pdf

Laura Kerber: Would you be able to do these missions using CLPS or SIMPLEX or similar? Barb Cohen: LEAG White paper to reinforce science belonging in Discovery and New Frontiers that can't be done with low cost missions.

Evolution of surfaces / geologic evolution of bodies with and without atmospheres

Daniel Moriarty: The Moon is a Special Place

- Need for this WP ID'd a last fall's LEAG meeting
- Community driven WP
- WP will ID critical science and exploration question relevant to the Moon
- Wholistic approach: orbital, landed, human, modeling, experiments, sample+data analysis

James Tuttle Keane: Crustal Dichotomies across the Solar System

- What is the origin of global asymmetry in bodies across the solar system
- Oldest structures, act as a datum, critical to understanding the formation of bodies in the solar system
- Catalog features, hypotheses, priority measurements to disentangle hypotheses.
- A few co-authors and welcomes more.

Laura Kerber: Secondary Crust Formation

- Moon is a unique place to study secondary crust formation
- 12 co-authors, so far
- Relation of secondary crust and plate tectonics
- Relation of secondary crust and secondary atmospheres (newish hot topic)

Ghent and Zellner: Recent (< Ga) Bombardment Flux Across the Solar System

- Science focus topic that came out of a recent LEAG meeting
- Important for understanding the evolution of the early solar system
- Lunar impact flux is used to determine the flux on other bodies in the inner solar system
- Looking for coincident/correlated events on multiple bodies
- Looking to connect big events in Earth's geologic past with impacts
- Connects to Barb C's WP (in situ age dating)

Brett Denevi: Lunar Regolith development and evolution

- The last decadal survey did capture the complexity of the regolith as well as it should.
- What is the regolith to mega-regolith (bedrock) transition

Depth of regolith is uncertain
Explore hypothesis for cold ejecta craters
Understand how regolith is generated and mixed over time
Pits (skylights) may provide a unique window into regolith development

Georgiana Kramer: The Plethora of Science Afforded by a Lunar Swirl
Technical difficulties

Dave Blewett
Lunar magnetic anomalies:
Three-part WP
1. Examine science questions associated with magnetic anomalies and Swirls
2. Measurements needed and survey of instruments that can make measurements
3. Consider Mission types

Michelle Thompson: Space weathering across the Solar System
Space weathering important for the interpretation of remote sensing data and recognizing environmental hazards and opportunities for humans exploration
Overlap with swirls (Kramer/Blewett), impact flux, and volatile generation

Xu Wang: Electrostatic dust transport on the Moon and airless bodies across the solar system
The fundamental question: how do particles get enough charge to be lofted
Understand the surface evolution of bodies (overlap with Denevi/regolith)
Promote lab experiments, computer models, in situ measurements

Sarah Valencia: High Priority Sites for Returned Lunar Samples
Build consensus for the highest priority sites to target for sampling
Strengthen the case for the value of returned samples v. in-situ measurements.
Needs to be written to be supportive of WP that promote science with remote sensing, in-situ analyses,

Laura Kerber: the importance of bedrock exposure
Bedrock samples give a better context for geochemistry, petrology, mineralogy than a complex mixture of regolith particles.
Overlap with Denevi/Regolith as it seeks paleo regoliths

Danial Moriarty: Sample Return from multiple Target Locations

- Need for this WP ID'd a last fall's LEAG meeting
- Understand the diversity of rock types and their horizontal/vertical context
- Overlap with Kerber/bedrock, Valencia/Return samples, Denevi/Regolith, etc.
- Overlap with Brad Jolliff: Sample Return from the Moon's South Pole-Aitken Basin
- Develop a single mission architecture to achieve goals of sampling multiple target locations
- Does this include Gateway in the architecture?
- Could be an introduction to WPs that it dovetails with

Tim Glotch: Next-generation lunar orbiter

- Looking for HEOMD co-authors and their input on this WP. To help with landing site locations and landing hazard assessment
- Trade studies for what can be done with smallsats v. large sats.

Any WP advocating science that can be done with small/cube sats

White Papers missing:

1. Early bombardment across the solar system
2. Impact process across all scales
3. Geophysical methods (e.g., thermal probes, seismometers)
4. Studies of the Moon's deep interior (inner evolution) also appear absent (except for Rene Webber's WP later on)
5. Magma ocean concepts missing
6. Measuring lunar surface volatiles and generation with experiments

Interior evolution and volcanism

Laura Kerber: Volcanism Across the Solar System

- Importance of volcanism in planetary formation in crustal formation, atmospheric formation, and understanding of planetary interiors,
- Volcanic flux could seed or destroy life
- Needs examples of critical topics to study

Sarah Valencia: End-member volcanism in the absence of plate tectonics: Silicic volcanism on the Moon

- Explore the phenomenon of the formation of silicic rocks on a one-plate planet
- Overview of silicic rocks: samples and formation mechanisms
- Compile a list of observations and outstanding questions.
- Application to other bodies in the solar system
- Mission concepts.
- Could have a connection to volatile evolution

Erica Jawin: Exploring end-member volcanism on the Moon at the Aristarchus Plateau

- Focus is on endmember volcanism at the Aristarchus Plateau
- Could this WP be combined with Valencia WP to strengthen and not dilute?
- Does it consider Intuitive Machines landing proposed for Aristarchus Plateau
- Didn't mention that Aristarchus Plateau was a constellation site

Sam Lawrence: Sampling the Youngest Lunar Basalts

- Overlap with Valencia: High Priority Sites for Returned Lunar Samples and Barb Cohen: Geochronology for the Next Decade
- Unit P60 basalts are critical as a calibration for crater size-frequency models, thermal history of the Moon.

Matt Siegler: Passive Microwave Radiometry

- Misson concept (landed, orbit, from Earth)
- Use emitted microwave/radio wave (100MHz-100GHz) to measure geothermal heat flux and probe subsurface for ice

Renee Weber: The rationale for the deployment of a long-lived geophysical network on the Moon

- The scientific rationale for deploying a global, long-lived network of geophysical instruments
- Mission concept study
- Propose operating through the lunar night. Lunar polar volatile measurements and ISRU need to (probably) promote this more
- Good catchphrase: Lunar science is solar system science

MIssion WP:

- What we have learned about the LMO since the SCEM report.
- Enabling Technologies that are needed to address the science.

Technology and human exploration

Kelsey Young: The interface between human exploration and lunar decadal science

- Artemis program, as a sustained program, demonstrates the value of humans on the Moon.
- What is the value of human brains on the surface of the Moon, in situ, opportunistic science, payload assembly, ground cover, pressurized and unpressurized vehicles.
- Evaluate high priority better done with humans
- Importance of mobility.
- Importance of analog field testing
- Use as a wide community effort as a well Reference white papers to help others.

Ryan Watkins: Understanding and mitigating plume effects during powered descents on the Lunar surface

- Understand and mitigate plume effects
- Current state of knowledge now: when rockets land on the surface of the Moon
- Particle size distribution, characteristics, etc…
- Physical alterations
- Multiple landings on the same site and/or prevent issues of plume effects.
- Polar and nonpolar regions

Joshua Cahill: Impacts flash/flux monitoring and its implications for exploration

- Recent impacts, paper at LRO, detected new craters, new impacts.
- Understanding flux, monitor humans and protect them while on the Moon.
- Improvement techniques to detect and study impacts. Concerns about impact flux: current impact flux from large to microscopic, primary or secondary.
- Random or is there a pattern? Doing activities from LRO data. Hazard assessment evaluation,influence operations, humans and robotic missions, habitats, etc…
- Discussion from image presented: Is there a distribution? No statistical data yet.

Georgiana Kramer: The mutuality between science and commercial exploration of the Moon

Esther Beltran: The importance of human missions vs. robotics for the more ‘bang for the buck’ in science return.

To reach out to Kelsey Young to combine efforts.

Stephen A. Bailey: Reconnaissance Drone for Lunar Exploration

Lunar hopper miniaturized to be carried out by astronauts to help them with the mission. Areas where it’s difficult to access. Quad Copter technology is ready to go and high TRL carries significant payloads. Full payload for 5 Km length, or lighter payloads further away regions, 1-way trip can go even further.
Allow in a way that can enhance operations that can augment human missions. Can have penetrators, drop probes, etc…can extend missions.

Elisha Jhoti: an ultra-low altitude lunar orbiter

Mission concept high resolution data is a requirement, critical to address while the surface is still pristine. Ultra-low orbiter altitude to understand the surface that helps really understand terrain. Model dynamics, cost-effective. Advance surface exploration & ISRU beyond LRO, better to learn with this orbiter probe for much higher resolution.

Ron Creel:Technologies for Lunar Night Survival and Operation

Talk about operations now not later, systems that operate at all levels. Different systems are helping from low TRL to high. Plans for implementation.
Comment: look at other concepts that require night survival and overlap with the other authors that have similar topics.

Jonathan Grandidier: Power beaming for Deep Space and PSRs

Concept of laser beaming without wires, transfer of power without wires. Laser beam only way to power robotics or instruments in PSRs, might be the only way to provide power. Provide power during the night. Beam power to a receiver during the lunar night. It’s already used in Army, terrestrial applications. End-to-end system design. Each subs-system has elements. Different distances across the surface terrain, needs to be optimized for space. Different authors are contributing to the paper now. Could have unexpected applications for Space.

Ron Creel: Isolation Technology for Lunar Dust Control

We might not be able to test for this issue here on Earth, dust is the major issue in Lunar space missions. We could overcome most of the problems but dust is probably the most difficult to solve.
Isolate, is the best way, example as in JSC, hazard at many levels. Lunar airlock is very critical for Moon missions.

Backup notes from Ashley Royce:

Kelsey Young- The interface between human exploration and lunar decadal science

-Demonstrates value of having Humans on the moon for in situ decadal science accomplishment Deployment of sensitive payments better completed by astronauts. Humans can cover more ground and complete high-priority sampling better . Importance of science and human space flight community collaboration

Ryan Watkins- Understanding and Mitigating Plume Effects during Powered Descents on the Lunar Surface

Hardware and environmental impacts (known and potential for future missions). Outstanding questions: particle size distribution lofted by exhaust fumes, particle direction, speed, volume, distance, etc.

Recommendations: Image descent on every landed mission, other measurements of plume effects.

*Ron creel: Any studies on S4B studies and how they impacted the moon?

*Ryan: Not aware, ask Phil Metzger

Joshua Cahill- Impact flash/flux monitoring and its implications for exploration

-What is the current impact flux large and small

-What techniques help us better understand what caused the impacts

-Distribution of impactors and range of influence

-Range of meteoritic infall size

-May influence operations of landers and robotics and how they weather the moon's conditions

Georgiana Kramer- The Mutuality Between Science and Commercial Exploration of the Moon

Enable transmission of power without wires

-Objective is to charge a small robotic power system located in a PSR from a solar powered lander located at the rim of the crater.

-May be only way to power in PSR

-Further term option is to provide power to lunar base from an orbiter during lunar night

Esther Beltran- “The Importance of human missions vs. robotic for more “bang for the buck” in science return

-How to implement human missions

-How to address the concepts of how humans can help the science from a science perspective

-Open to joining other authors to combine similar topics together

Stephen A Bailey- Reconnaissance Drone for Lunar Exploration

-Need for Drone that can complete many smaller missions

-Exploring areas that are hard to access/cross, slopes, landing sites, interiors of lava tubes

-TRL9 using conventional technology, carrying 9kg science payload and 10kg of propellent, can cover 10km round trip or 160km one way trip

-Can take small pails from lunar surface to low lunar orbit

-Augment the human and robotic missions

-Powered by batteries and self-charges, outfitted with variety of different equipment for sample acquisition and return

Elisha Jhoti- An Ultra-Low Altitude Lunar Orbiter

-High resolution data required for next decade of lunar exploration

-Advance surface exploration and ISRU beyond LRO

-Low-altitude flight during duration of mission

-Orbiter would be sustainable and cost effective due to remaining in orbit

-Use agile thrusters to evade gravity perturbations and lunar topography

Ron Creel- Power Technologies for Lunar Night Survival and Operation

-Need to go beyond lunar night survival to night operation

-Highlighting systems at various TRL's for lunar night survival power technologies

Jonathan Grandidier- Laser Power Beaming for Deep Space and Permanently Shadowed Regions

- Enable transmission of power without wires

-Objective is to charge a small robotic power system located in a PSR from a solar powered lander located at the rim of the crater.

-May be only way to power in PSR

-Further term option is to provide power to lunar base from an orbiter during lunar night

Ron Creel- Isolation Technology for Lunar Dust Control

-Earth-based moon environment simulation & testing is very difficult and not reliable

-Isolation from lunar dust is required for successful future moon operations

-Best long term solution includes a lunar dust isolation airlock/mudroom

Session Discussion:

-Question to Jonathan on beam, microwave. On the Moon we don't have an atmosphere that blocks some wavelengths and might be easier to power the beam.

-Question for dust mitigation; electrostatic mitigation for dust. Might work on Earth but not on the Moon. Time to clean, it takes too much time. Cleaning-area or room is important for operations.

-Nuclear reactor on the Moon? Want to work together to push for technology. Applied side on the space exploration side will require more energy, Decadal Survey might not be the right route to push for Kilopower requirements at this time, for this decadal, but it's important for ISRU, etc....

-Have different white papers to cross-over and make recommendations. Good to reference information from white papers.

-End of taking notes from Technology and Human exploration-.