# Goals and Priorities of the Lunar Exploration Analysis Group

Amy L. Fagan

Chair, Lunar Exploration Analysis Group (LEAG)

Western Carolina University

Dr. Amy L. Fagan
For the Lunar Exploration Analysis Group

Given to Decadal Survey on Planetary Science and Astrobiology
Panel on Mercury and the Moon

Friday, 20 November 2020

# LEAG Goals and Priorities are laid out in…

- Lunar Exploration Roadmap (LER)
- Specific Action Team Reports (SATs)
- Annual Meeting Findings (Findings)
- Official LEAG Whitepapers (OWLs)
- https://www.lpi.usra.edu/leag/

Sustainable human presence **on** the Moon is critical for sustainable human exploration **beyond** the Moon

- Artemis
- Government-Commercial partnerships
- Resource utilization
- Lunar science answers solar system science questions
- Diverse teams and people

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The Moon is an enabling asset that unites our exploration goals across different destinations and the foundation to humanity's understanding of our place in space and time.

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# LEAG Represents a Large, Vibrant Community

- "…to **support** NASA in providing **analysis** of scientific, technical, commercial, and operational issues in support of lunar exploration objectives and of their implications for lunar architecture planning and activity prioritization."

- **Interdisciplinary** group including members for every aspect of lunar exploration community:
  - Lunar and Planetary scientists
  - Life scientists
  - Engineers
  - Technologists
  - Human systems specialists
  - Mission designers
  - Managers
  - Other professionals

Different Sectors
- Academia
- Industry
- Government
- Commercial

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# Executive Committee Represents Several Sectors

| | |
|---|---|
| **Chair, LEAG** | Dr. Amy Fagan, *Western Carolina University* |
| **Emeritus Chair** | Dr. Samuel Lawrence, *NASA JSC* |
| **Science Chair** | Dr. Brett Denevi, *Johns Hopkins University APL* |
| **Human Exploration Chair** | Dr. Kelsey Young, *NASA GSFC* |
| **Technology Chair** | Dr. Jose Hurtado, *University 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/ University of Maryland* |
| **Equity, Diversity, & Inclusion Chair** | Dr. Kristen Bennett, *USGS* |
| **Astrophysics Community Liaison** | Dr. Alexander Hegedus, *University of Michigan* |
| **Member-at-large** | Dr. Ryan Watkins, *Planetary Science Institute* |
| **Member-at-large** | Dr. Benjamin Greenhagen, *Johns Hopkins University APL* |
| **Chair, Commercial Advisory Board** | Dr. Elizabeth Frank, First Mode Inc. |

*Ex Officio Members:*

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

# Lunar Exploration Roadmap

- Product of past, present, and future
- Living document
- The document's charge:
  - Map science goals to objectives, observations, measurements;
  - ID technological developments;
  - Coordination with commercial and international partners;
  - Feed-forward activities (explore Mars and beyond)

- Prioritizes Science and Time-phasing
- 3 major themes:
  - Science
  - Feed-Forward
  - Sustainability

- Lunar Science is Solar System science
- Sustainable human presence **on** the Moon is critical for sustainable human exploration **beyond** the Moon

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# Specific Action Teams and Workshops (2015-2020)

- Volatiles
- Strategic Knowledge Gaps
- Next Steps
- Advancing Science on the Moon
- Survive and Operate through Lunar Night
- COSPAR Planetary Protection

- The Moon is an enabling asset
- Unites exploration and science goals across destinations

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# LEAG Community Findings at Annual Meetings

## 2019 Findings

- Artemis
  - Sample return mass
  - Develop permanent presence
- Lunar Resource Prospecting
  - Strategy: Goals and Objectives
- Science and Exploration Strategy
  - Mission opportunities
  - Commercial Lunar Payload Services (CLPS)
- New Frontiers 5
  - Lunar Geophysical Network
  - South Pole Aitken (SPA) sample return
- Diverse Teams and Leadership
- LEAG Contributions to long-term plans

## 2020 Findings (a subset)

- Artemis
  - Sample return mass
  - Crew time on surface
  - Mobility
  - Communications Satellites
  - Artemis Base Camp
- Sustainable Exploration
  - The Moon's place in exploration
  - Coordination and Collaboration
  - Lunar Program Office
  - Lunar Resources
  - Orbital Assets
- R&A Funding
- Diversity, Inclusion, Equity, and Accessibility
- Commercial Advisory Board

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# LEAG Supported White Paper Production

- LEAG 2019 annual meeting (October 28-30, 2019)
  - Breakout Big Picture Science Focus Groups:
    - Solar Systems
    - Planetary Formation
    - Planetary Geology
    - Habitability
    - Resources

    → Identify outstanding lunar science goals → Identify missions (why Moon, why now?) → Potential white papers (Google Doc. 77)
- LEAG/SSERVI joint virtual meeting (May 20, 2020)
  - Meeting Goals:
    - Facilitate collaboration/discussion
    - Solidify commitments, coauthors, and signatories
    - Identify gaps and needs

# 4 Official LEAG White Papers Submitted

- 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

# 4 Official LEAG White Papers Submitted

- The Importance of Human Exploration in Accomplishing High Priority Lunar Science Objectives (Lead Author: Dr. Kelsey Young)
  - Recommendation: The lunar science community should be integrated with the human spaceflight community to ensure adequate understanding of lunar science objectives and criteria for success.
  - Recommendation: The Planetary Science Decadal Survey should include a strategy for maximizing lunar science through human exploration, not just through the more traditional orbital and landed missions.

# 4 Official LEAG White Papers Submitted

- Lunar Missions for the Decade 2023-2033 (Lead Author: Dr. Barbara Cohen)
  - Recommendation: New Frontiers missions include…
    - Lunar Geophysical Network
    - Solar System Chronology (sample return or in situ dating)
    - Long-Range Geologic Explorer
  - Recommendation: Advocate for lunar missions that accomplish Solar System science in the Discovery and SIMPLEX programs.
  - Recommendation: Initiate Studies for…
    - Lunar Permanently-Shadowed Region Volatiles Explorer mission
    - Next Generation Lunar Orbiter mission
  - Recommendation: Investigate potential mission partnerships
  - Recommendation: Highlight enabling technology investments

# 4 Official LEAG White Papers Submitted

- Planetary Science Priorities for the Moon in the Decade 2023-2032: Lunar Science is Planetary Science (Lead Author: Dr. Erica Jawin)
  - Recommendation: Prioritized recommendations in community documents are still valid such as:
    - 2007 NRC Report: Scientific Context for Exploration of the Moon
    - Advancing Science of the Moon Specific Action Team
    - Lunar Exploration Roadmap
  - Consider critical role of team dynamics, equity, diversity, inclusion, and accessibility in planetary science

# 4 Official LEAG White Papers Submitted

- The Moon is a Special Place (Lead Author: Dr. Daniel P. Moriarty III)
  - Recommendation: The Moon provides a critical foundation for achieving fundamental planetary science and exploration goals. The Moon remains a target of the highest priority.
  - Recommendation: A robust program of lunar science and exploration, including orbital missions, robotic sample return, in situ analyses, human exploration, numerical modeling, laboratory experiments, terrestrial analog work, sample analyses, and data analysis.
  - Recommendation: The lunar science community will be greatly strengthened through a clear commitment to diversity, inclusion, education, and public outreach.

# Artemis Priorities are Planetary Science and Exploration Priorities

- Objective 1: Understanding Planetary Processes
- Objective 2: Understanding the Character and Origin of Lunar Volatiles
- Objective 3: Interpreting the Impact History of the Earth-Moon system
- Objective 4: Revealing the Record of the Ancient Sun and Our Astronomical Environment
- Objective 5: Observing the Universe and the Local Space Environment from a Unique Location
- Objective 6: Conducting Experimental Science in the Lunar Environment
- Objective 7: Investigating and Mitigating Exploration Risks

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*"The overarching theme of lunar science is that understanding the evolution and character of our home (the Earth-Moon system) helps us understand our solar system and enables us to plan for and protect an extended future."*

-LEAG/SSERVI joint virtual meeting on Decadal Survey community inputs

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# Credits and Useful Links

- Left panel Shackleton Crater image credit: NASA/GSFC/Arizona State University

- Lunar Exploration Roadmap: https://www.lpi.usra.edu/leag/roadmap/
- Specific Action Team and Workshop Reports: https://www.lpi.usra.edu/leag/reports/
- 2019 annual meeting findings: https://www.lpi.usra.edu/leag/meetings/2019_Findings_Final.pdf
- White Paper support:
  - 2019 annual meeting Presentations of Breakout Group Summaries: https://www.youtube.com/watch?v=L-nIjzxoy4g&feature=youtu.be
  - 2019 annual meeting Spreadsheet: https://docs.google.com/spreadsheets/d/1iT4Bo_NhRGGXuEqnaEYRTBHA3SS6XSalTFPplSiQSik/edit#gid=472923996
  - LEAG/SSERVI Virtual meeting 2020: https://docs.google.com/document/d/19sPg_1fDUHUiQ5saFiINrGDTE-aB1NftxC4nTfC5W78/edit